RECORDS

of the

AUCKLAND INSTITUTE AND MUSEUM

Volume 13 December 10th, 1976

RECORDS of the AUCKLAND INSTITUTE AND MUSEUM

Volume 13 December 10th, 1976

Published by Order of the Council

E. G. Turbott, Director

Address: Auckland Institute and Museum

Private Bag, Auckland, New Zealand

RECORDS OF THE AUCKLAND INSTITUTE AND MUSEUM

VOLUME 13

CONTENTS

ARCHAEOLOGY AND ETHNOLOGY — Page

Additional evidence from the excavations at Skipper's Ridge, (N40/7), Opito, Coromandel Peninsula.
JANET M. DAVIDSON 1

A Nukuoro fishing kit in the Pitt Rivers Museum, Oxford.
JANET M. DAVIDSON 9

Pa and other sites in the Parua Bay District, Whangaroa, Northland.
AILEEN FOX 13

Whakamoenga Cave, Taupo, N94/7. A report on the ecology, economy and stratigraphy.
ANNE LEAHY 29

The Tahanga Basalt: an important resource in North Island prehistory.
P. R. MOORE 77

BOTANY

New and interesting records of adventive plants from the Auckland Institute and Museum Herbarium 2.
E. B. BANGERTER 95

Notes on the Cheeseman Herbarium Part 3. Exchange with Australian herbaria from before 1900 to 1923.
JEANNE H. GOULDING 101

Rediscovery of *Gonocarpus trichostachyus* (Haloragaceae).
A. E. ORCHARD 109

ZOOLOGY

The taxonomy of some Indo-Pacific Mollusca. Part 4. With descriptions of new taxa and remarks on *Nassarius coppingeri* (Smith).
W. O. CERNOHORSKY 111

Notes on the taxonomy of Indo-Pacific Terebridae (Mollusca: Gastropoda), with description of a new species.
W. O. CERNOHORSKY and T. BRATCHER 131

On the considerable influx of warm water molluscs that have invaded northern New Zealand waters within recent years.
A. W. B. POWELL 141

Gill damage in fish produced by buccal parasites.
A. B. STEPHENSON 167

Index 175

ADDITIONAL EVIDENCE FROM THE EXCAVATIONS AT SKIPPER'S RIDGE, (N40/7), OPITO, COROMANDEL PENINSULA

JANET M. DAVIDSON

AUCKLAND INSTITUTE AND MUSEUM, AND

LADY MARGARET HALL, OXFORD

Abstract. Three recently found representative cross-sections of the excavations at Skipper's Ridge in 1959 and 1960 are presented and their significance discussed.

Since the publication of a report on the excavations at Skipper's Ridge in 1959-60 (Davidson 1975), several cross-sections have been discovered in the Anthropology Department, University of Otago. Their discussion here is intended as a supplement to the previous report and should, if possible, be read in conjunction with it.

The statement in the previous report, that the original field drawings of stratigraphic sections of the excavations from May 1959 onwards were missing, remains correct. The recently discovered drawings are representative cross-sections, redrawn at a large scale (2½ inches = 1 foot) (63.5 mm = 0.3048 m) at some stage after the completion of the excavations. The cross-sections have been arbitrarily numbered as follows: Cross-section 1, A - A^1; Cross-section 2, B - B^1 Cross-section 3, C - C^1. Cross-section 1 appears to date from an early stage in the excavations, probably May 1959; the other two, because of their positions, probably derive from the final excavations in the summer of 1959-1960.

The positions of the three sections are shown on the plan of structures uncovered during the excavations (Fig. 1). The redrawn sections are illustrated in Fig. 2. Cross-sections 2 and 3 have been related to the site datum. Although there is no precise means of checking the datum of Cross-section 1 from the evidence available, it is probably approximately the same as the site datum.

THE CROSS-SECTIONS

Cross-section 1 represents the west face of square D7, one of the two original test squares. It is labelled "Section along W side from S-N Square 7D". The use of the form 7D rather than the later D7 shows that this section derives from an early stage in the excavations. This is supported by the fact that the occupation I pit D, through which the section runs, is defined but not fully excavated. The original test square in January 1959 was taken down to this point, but as the records of that excavation were retained by Golson, I assume that this section derives from the reopening of the square in May 1959. It is interesting that a 10-foot (3.05 m) rather than a 9-foot (2.7 m) square is suggested. This may be

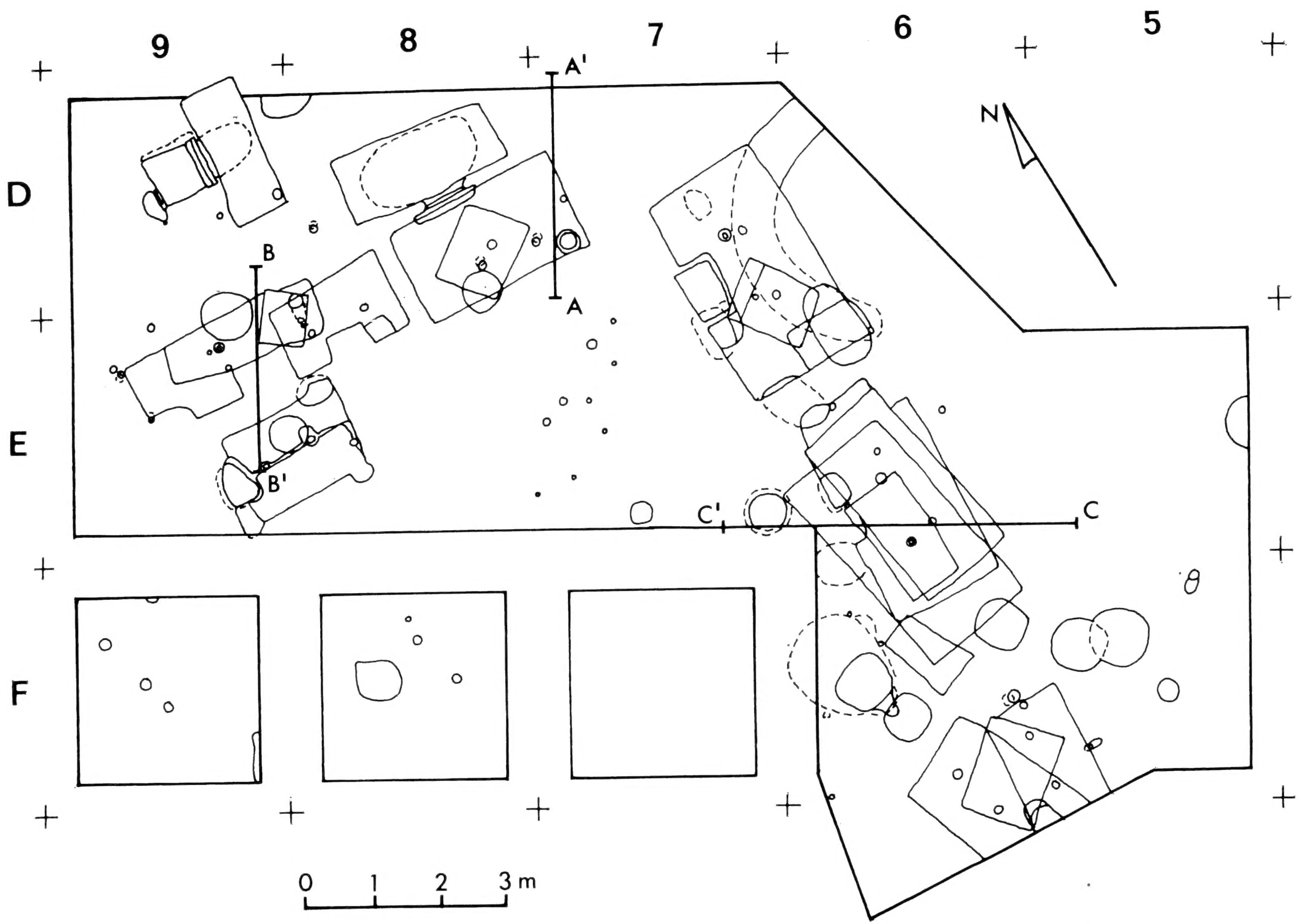


Fig. 1. Plan of excavated structures at Skipper's Ridge, N40/7, showing positions of cross-sections. Cross-section 1, A - A[1]. Cross-section 2, B - B[1]. Cross-section 3, C - C[1].

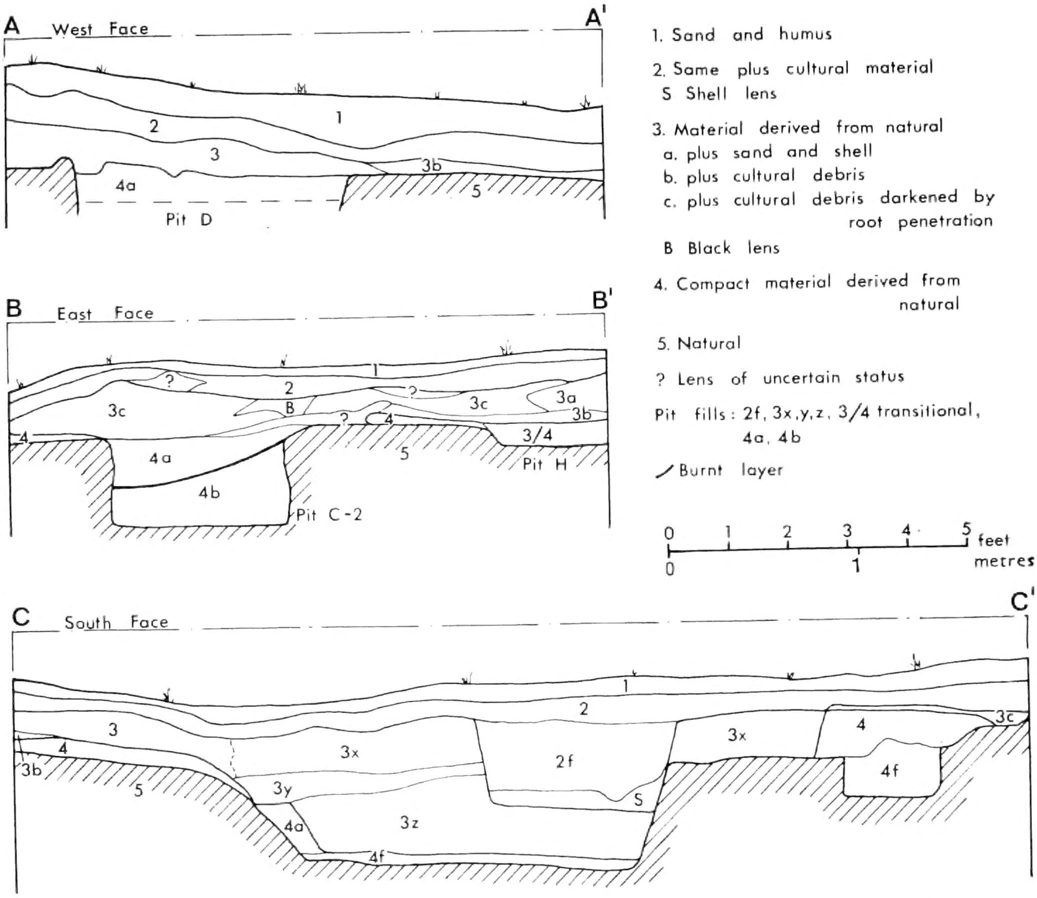


Fig. 2. Three cross-sections, Skipper's Ridge, N40/7. Cross-section 1, A - A[1] along West face of square D7. Cross-section 2, B - B[1] along East face of part squares D9 to E9. Cross-section 3 C - C[1] along South face of part squares E5 to E7.

an error either in the original drawing or in the redrawing; however, the position and dimension of pit D on the section conforms best with a hypothetical 10-foot square within the 12-foot (3.7 m) site grid.

The stratigraphy in this area is relatively simple and the layers in the section agree with written descriptions of this part of the site. Layer 4 appears only in the fill of the pit, which is sealed by layer 3. The stratigraphy here is similar to that in the previously published section across pit E in the south-east corner of the same square (Davidson 1975, fig. 1), except that the layers are thicker, remarkably so in the case of layer 1. This may be due to the difficulty of distinguishing the boundary between layers 1 and 2.

Cross-section 2 represents part of the east face of squares D9 and E9 after the removal of the intervening baulk. It is actually labelled "Section east to west across pit complex of Squares E5-E6", but it is obvious from a comparison with the plan of structures that the labels of Cross-sections 2 and 3 have been reversed. There is a slight inaccuracy in that the distance between the two pits on the section is greater than that indicated on the plan.

This section, which bisects pit C-2 and part of pit H, unfortunately misses the complex intersection of C-2, C-3 and G, and consequently throws no light on the interpretation of pit C as a whole. Several important points emerge, however. Both pit C-2 and the northern part of pit H were cut through remnants of layer 4 and sealed by layer 3, here a rather complex deposit with several components. The small lens of layer 4 visible in the section between the two pits is one edge of a thicker remnant, whose extent is marked on the original plan. This remnant shows clearly in several black and white photographs. The extreme shallowness of pit H is therefore partly due to subsequent truncation of that part of its walls not formed by the natural. An original depth of rather more than 1 foot (30 cm) for pit H is probable.

The infilling of pit C-2 is illustrated both in this section and in several black and white photographs of the north face of square E9 both before and during the removal of the E9-D9 baulk. In these photographs, the burned layer shown on Cross-section 2 is clearly visible, sloping down from east to west. It seems that this pit was filled originally from the south-east or east, and completely filled and levelled after the burning episode.

Cross-section 3 (originally labelled "Section N-S across pit complex of squares D9-E9) represents the south face of part of squares E5-E7. It is one of the key sections of the site as it bisects the complex series of pits F, K, L and S, as well as one of the occupation I "potholes". A coloured slide of part of this section, taken by H. J. R. Brown, shows that the differences between layers in the pit fills were minimal, so that the pits themselves were very difficult to define. It is therefore not surprising that there are some slight discrepancies between the boundaries of features on the section and on the plan.

One of the earliest features in this part of the site, if not the earliest, is the occupation I "pothole" in the south of E7, which is sealed by a large remnant of layer 4, possibly derived from the original digging of pit F. The relationship of the occupation I buttress pit F to layer 4, however, is not clear, owing to the intrusion of the later pits attributed to occupation III (layer 3).

The general sequence of pit construction in this area is the same as that previously reported. A relatively large deep pit was dug and subsequently filled with layer 4; a slightly shallower pit on a slightly different alignment was dug in the same place, removing much of the layer 4 fill, and in its turn filled with layer 3. Into the top of this a large shallow feature was dug, which nowhere penetrated the natural, but was dug partly into layer 4, and partly into the earlier of the layer 3 deposits. This in turn was filled with layer 3. Finally, a smaller pit was dug in the same area and filled, after which the build-up of layers 2 and 1 completed the sequence. The problem is to reconcile the boundaries of the pits, as shown on the section, with those given on the plan. The section suggests that the east wall of pit F (occupation I) at this point lay further to the east than that of pit K (occupation III). In the plan, however, the reverse is the case. This could suggest that pit K, a rectangular pit without buttress, is earlier than the buttress pit F. However, the otherwise consistent evidence that the buttress pits are the earliest features on the site, suggests that the confusion has arisen from the great difficulty of precisely determining the boundaries of individual features in this complex part of the site.

Confidence in the existence of pit L is not increased by this section. Its walls were evidently clear where it was cut into layer 4 (on the west and south sides) and unclear where it merged with widespread layer 3 deposits. On the evidence of this section, its status as a pit seems doubtful. On the other hand, pit S, assigned by Parker to layer 2 (occupation IV), is more definite. Although it is certainly the latest pit in this part of the site, it appears to precede the main accumulation of layer 2, and may thus be the last occupation III feature, rather than a true occupation IV feature.

Discussion

The sections, in my view, support the idea of continuity between occupations I, II and III. Parker defined both layer 4 and layer 3 as redeposited natural with greater (layer 3) or lesser (layer 4) amounts of cultural material incorporated. Subdivisions of both layers were defined; but these all appear to represent material derived from the digging of pits and perhaps other features, and mixed with increasing amounts of cultural debris resulting from occupation on the site.

The problems of association of artifacts and midden from the site with structural features are emphasised by the sections. For example, material from layers 4b and 4a in the fill of pit C-2, as illustrated in Cross-section 2, is stratigraphically later than material from layer 4, through which the pit was cut. However, the original context of items found in pit fills must always be uncertain. Similarly, the original contexts of material found in the various layer 3 fills and deposits illustrated in Cross-section 3 are unknown, and it is quite probable that some of them, at least, would derive from earlier, disturbed and redeposited, layer 4 deposits. The general similarity in the range of material attributed to layers 3 and 4, and the hydration rim readings (Davidson 1975, p.37) suggest that material from these two layers should probably best be regarded as a single assemblage, broadly contemporary with the pits on the site.

On the other hand, layer 2 is shown everywhere as later than all pits, and with the rather doubtful exception of pits Q, R and S, not associated with pits at all. Although pit S is shown on Cross-section 3 as having a layer 2 fill, it is also shown as sealed by the main layer 2 deposit. The colour slide of the same section suggests that the fill of pit S is not significantly different from the layer 3 fill of the adjacent "pit" L. It therefore seems probable that pit S is the last occupation III feature in this part of the site. Reinterpretation of pit S and perhaps the very doubtful pit Q as part of occupation III, would remove one of the best arguments for continuity between occupations I to III on one hand, and occupation IV on the other, while strengthening the already strong argument for continuity in occupations I to III.

If the pits on the site are regarded as a single assemblage built over a period of time by people who adhered closely to a single site plan, some reinterpretation of occupations I, II, and III is necessary. The division into occupations was initially made by Parker on the basis of alignment, fills and intersections of structures, at a time when he was developing his thesis of cultural difference between occupation I (Archaic A) and occupation III (Archaic B).

One area where reinterpretation is possible is the nature and relationship of pits C and H. Cross-section 2 shows that there is no direct stratigraphic evidence

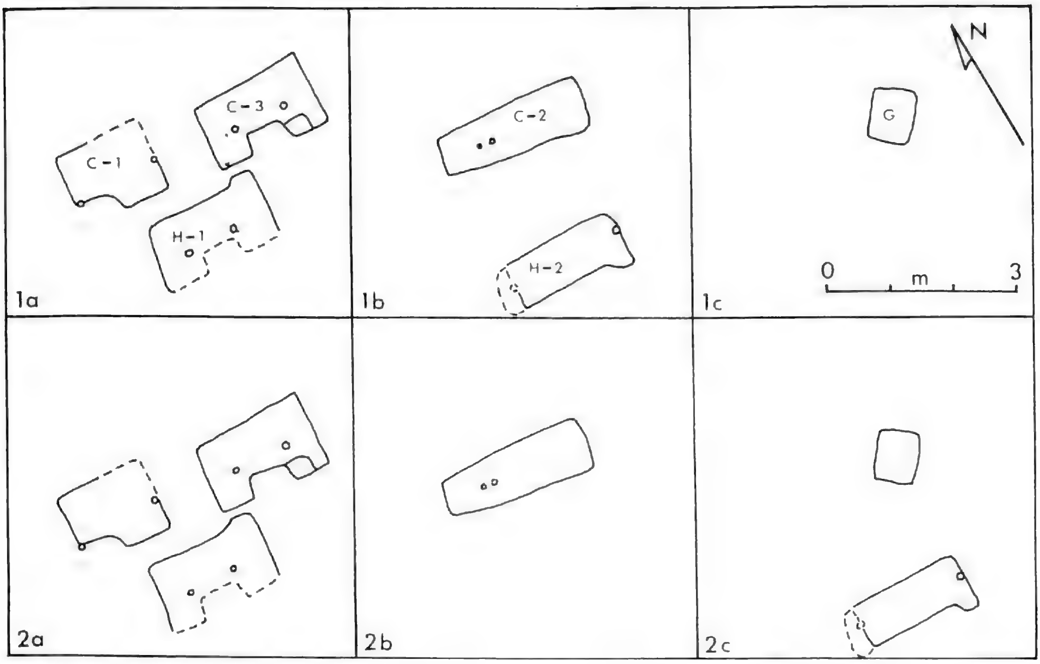


Fig. 3. Two hypothetical pit sequences, 1 a - c, 2 a - c, incorporating pits C-1, C-2, C-3, H-1, H-2 and G.

as to which, if either, of these structures is earlier, since both are cut through layer 4 and sealed by layer 3. Their relationship was therefore assessed from their fills, the fill of pit H being correlated with that of pit G, which was stratigraphically later than pit C. On other grounds, however, I believe another interpretation is possible. This assumes that both pit C and pit H are in fact more than one pit, a possibility which has already been suggested (Davidson 1975, pp.9 - 10, 14). A photograph of the north face of square E9 shows that if Pit C - 2 is separate from C - 1 it must be later. Unfortunately, Cross-section 2 does not extend right across pit H, and there is no photograph of this part of the section. However, photographs of pit H, after excavation, suggest that two small superimposed pits are involved. Study of the proportions and posthole patterns of the various occupation I pits leads me to believe that pit H may include remains of a small buttress pit, contemporary with Pits C - 1 and C - 3 (Fig. 3 — 1a, 2a), and a later plain rectangular pit, perhaps contemporary with either C - 2 (Fig. 3 — 1b) or G (Fig. 3 — 2c). These two alternatives are shown as hypothetical sequences in Fig. 3 (1a - c, 2a - c).

On the existing stratigraphic evidence, the "potholes" may well be the earliest features on the site. Clearly the question of their function, particularly whether they too could be for food storage, is important and deserves further consideration.

The complex of aligned pits, mostly with side buttresses, previously illustrated as occupation I (Davidson 1975, fig. 2), probably represents the next use of the site after the potholes. Possible modifications to this plan would be the reinterpretation of pits C and H, presented above; the possibility that a plain rectangular pit preceded the buttress pit F; and the always present possibility that the underground pits A and B are not truly associated with this occupation.

If the reinterpretation of pits C and H is accepted, there is little reason to postulate a separate occupation II. Rather it would seem that after the end of the useful life of the occupation I pits, pits of various sizes and shapes continued to be built in the same general alignment and positions throughout the build-up of layer 3, perhaps until the possibilities of this part of the site for pit building were exhausted, because of the increasing softness of the accumulating fill deposits.

The subsequent build-up of layer 2 may, as previously argued, represent merely a shift in use of this part of the site, at an even later stage in the same occupation, or a subsequent reoccupation after a period of abandonment. Only pit R it likely to have been associated with this reoccupation, and in the absence of a stratigraphic section including pit R, this too remains uncertain. On balance, the interpretation of layer 2 as later and distinct from the preceding group of occupations, now seems more attractive. In either case, it is probably safe to regard the portable material from layer 2 as a separate assemblage, distinct from that of the earlier layers.

Conclusion

Three cross-sections through key areas of Skipper's Ridge provide additional evidence for the interpretation of structural and portable remains. It seems likely that layers 3, 4 and 3/4 transitional, and the structures assigned to occupations I, II, and III, represent continuous or repeated occupation of the site by a community who adhered consistently to a single site plan, although varying the structures they constructed through time. The portable material found in these layers cannot, for the most part, be associated directly with any of these structures, nor confidently related to successive occupations. It should rather be regarded as a single assemblage broadly contemporary with the use of the site for pit construction.

On the other hand, the material from layer 2 probably does represent a separate and later assemblage, belonging to an occupation of a different character, with which only one pit, the rua R, is possibly associated.

REFERENCE

Davidson, Janet M.

1975 The excavation of Skipper's Ridge (N40/7), Opito, Coromandel Peninsula, in 1959 and 1960. *Rec. Auckland Inst. Mus.* 12:1-42.

A NUKUORO FISHING KIT IN THE PITT RIVERS MUSEUM, OXFORD

JANET M. DAVIDSON

AUCKLAND INSTITUTE AND MUSEUM, AND

LADY MARGARET HALL, OXFORD

Abstract. A pad and fourteen fishhooks, including a small trolling lure, from Nukuoro Atoll, are described.

Until well into the nineteenth century, Nukuoro fishermen often kept fishhooks in pads specially made for the purpose, known as *suu*. Some of these pads, with or without their full complement of hooks, are preserved in ethnographic collections, although their provenance is often not recognised. Two such pads were illustrated by Beasley (1928, plates LX, LXI) in his pioneering work on Pacific island fishhooks, but attributed by him to Tahiti. This attribution was repeated by Anell (1955, plate III), who illustrated a third pad in the Musée de l'Homme.

The probability that these pads were not from Tahiti but from the Polynesian outlier of Nukuoro in the Eastern Caroline Islands was suggested by Emory and Sinoto (1965, p.88) following their excavation and study of fishhooks from Tahiti and other East Polynesian island groups. Subsequently, excavation of a large collection of fishhooks on Nukuoro itself, identical to the hooks on the pads in question, has confirmed the Nukuoro provenance beyond any doubt (Davidson 1967, p.191; 1971, p.41).

I have discussed elsewhere (Davidson n.d.) the two pads illustrated by Beasley, one of which is now in the British Museum, and two in the Musée de l'Homme, including that illustrated by Anell. The purpose of this paper is to describe another pad and fishhooks in the Pitt Rivers Museum, Oxford.

The specimen, 1921.90. 139 (Fig. 1), consists of a small pad containing six pearl shell fishhooks; a further eight fishhooks (1921.90.140-147) are now attached to a piece of cardboard. All fourteen hooks were presented to the Pitt Rivers Museum by J. P. Mills in 1921 as a single collection, the only documentation being that they were found in a drawer at Bramall Hall, Bramall, Cheshire. The hooks conform to known Nukuoro types, and although it can no longer be determined whether they represent two separate small kits of six and eight hooks, or a single larger one of fourteen, there is no doubt that they all originated on Nukuoro.

The Pitt Rivers Museum specimen, like those previously described, is made of pandanus strips folded to form a flat rectangular pad stitched together with cord similar to that used in the fishing lines (cf. Beasley 1928, p.41). It measures

Fig 1. Nukuoro pad with fishhooks. Top. Pad and hooks. Bottom. Hooks on cardboard. (Photo: by courtesy of Pitt Rivers Museum, Oxford).

15 x 7 cm, somewhat smaller than other recorded examples. The stitching binds the pad together and provides the loops through which the hooks are slipped. If every loop held a hook, there would be approximately 40 hooks in the pad, although the size of the existing hooks suggests that the pad may not have been intended to hold so many. There would, however, be ample room for the other eight hooks in the set, especially if the lines were differently arranged.

The six hooks now in the pad consist of three examples of the archaeological Type V (known to Nukuoro informants as *maimoni* or *buledago,* probably the former) (Fig. 1, middle of pad) and three examples of Type VII (*gadinibidi*) (Davidson 1976) (Fig. 1, 2 left, 1 right). Type V is U-shaped hook, which could be used in a variety of sizes to catch a variety of fish. Type VII is a distinctive form with straight shank leg, fairly consistent in size, used for catching small fish known as *gina* inside the lagoon. These two types of hooks have a similar lashing device and are likely to be found together in approximately equal numbers in individual fishing kits (for example, Beasley's kit, now in the British Museum, has 17 Type V, 16 Type VII, and 6 others). The lashing on each of these six hooks is well preserved, and all except the largest have relatively long lines. All have traces of very fine lines to attach the bait, only three of which are complete. (Bait lines are deemed to be complete if they end in a small knot rather than a frayed end.) The smallest of the Type V hooks (Fig.1, top of pad) has a complete bait line of 18 cm. The largest of the Type VII hooks (Fig.1, bottom right) has a complete bait line of 57 cm. The other two Type VII hooks have a complete line of 13 cm and one frayed off at 14 cm.

The hooks now attached to the piece of cardboard include three more examples of Type VII (Fig. 1, left of cardboard), four others (Fig. 1, bottom and right), and a small trolling lure (Fig.1, middle top). The three hooks of Type VII are similar to the three in the pad. Although the snoods are in good condition, however, the lines are short and the bait lines in all cases frayed off near the point of attachment to the hook. The other four one-piece hooks on the cardboard resemble each other in shape, and include a larger pearl shell example and three smaller hooks of turtle shell. The remains of snoods on the pearl shell hook and one of the turtle shell hooks are very similar to the snoods on other hooks in the set. One of the unsnooded hooks has tiny lashing grooves on the outside of the shank leg, similar to those normally found on pearl shell hooks of Types V and VII. Moreover, hooks of similar shape appear in two of the other Nukuoro pads, although no complete hooks of this shape were found in the excavations on Nukuoro. Turtle shell, of course, does not survive long in the conditions there. Informants on the atoll spoke of additional types to those excavated, including small turtle shell hooks known as *madau gina* and *madau belubelu,* and hooks apparently similar in shape to those under discussion here, known as *lou.* It seems certain, then, that these hooks are from Nukuoro, and represent another type or types in use at the close of the prehistoric period, but not present in the archaeological collection, which was obtained largely from a single site.

The presence of a small trolling lure in this set of hooks is of great interest. Both large and small pearl shell lure shanks were found in the excavations on Nukuoro, but were very uncommon compared with one-piece hooks. Informants tended to belittle the differences in techniques of fishing with one-piece bait hooks and trolling lures, suggesting that all Nukuoro hooks were used from a moving canoe, and that use of a lure or a one-piece hook, at least for some kinds of fish, was simply a matter of individual preference. The presence of one small lure among 13 one-piece hooks adds some support to this assertion, indicating that a lure could be included in a fisherman's kit otherwise composed of bait hooks.

The shank of this small lure is almost identical to one obtained by excavation on Nukuoro (Davidson 1971, p.45 and fig. 21b). The ethnographic specimen is 3.3 cm long, with maximum width and thickness of 0.4 cm. The excavated specimen is 3.05 cm long with maximum width and thickness of 0.4 cm. The two are very similar in shape, with triangular cross-section, pointed proximal tip with bilateral perforation, and greatest width in the centre. The point lashing of the ethnographic specimen obscures the lashing grooves on the shank, but there are probably three or four, as on the excavated specimen.

The ethnographic specimen is valuable in demonstrating how the archaeological example probably appeared when it was complete and in use. The turtle shell point has a slightly expanded base, but with neither proximal nor distal projection, and two perforations, through both of which the point lashing passes. The line is drawn through the more proximal (and higher) of the two perforations. Unfortunately, the proximal end of the lure is damaged, with the tip of the shank broken and the attachment of the line no longer complete, but it is evident that the lashing here would have followed the widespread Polynesian pattern. The hackle is a piece of bast caught under the distal end of the point lashing. There are no filler sticks. In view of the rarity of securely documented lures from Nukuoro these details are of considerable importance.

As noted above, it is not certain whether these 14 hooks represent one fisherman's kit or two. The generally poorer condition of the eight hooks on the piece of cardboard (incomplete or absent snoods and lines) may indicate that they come from another pad which has disintegrated. On the other hand, the fact that they belong to a single collection with no other hooks associated, and the known propensity of some collectors to remove hooks in order to reveal details of the pad (cf. Beasley 1928, p. 42 and plate LXI) suggest that they probably do belong to a single set. In either case, all are from Nukuoro, and provide further evidence on the range of types in use at the close of the prehistoric period and the proportions in which the different types may occur. Most importantly, this collection shows that small trolling lures, such as were found in small numbers in the excavations on Nukuoro, could form part of fishing kits consisting predominantly of one-piece bait hooks of various types.

Acknowledgements. I am grateful to Mr R. R. Inskeep, Acting Curator of the Pitt Rivers Museum, for enabling me to study the fishhook collection, and to Elizabeth Sandford Gunn for her encouragement.

REFERENCES

ANELL, Bengt

1955 Contribution to the history of fishing in the southern seas. *Studia ethnogr. Ups.* IX. xx, 249 pp. illus. 8 pl.

BEASLEY, Harry G.

1928 *Pacific Island records: fishhooks.* Seeley and Service, London. xxiv, 133 pp. illus. 192 pl.

DAVIDSON, Janet M.

1967 An archaeological assemblage of simple fish-hooks from Nukuoro Atoll. *J. Polynes. Soc.* 76 (2): 177-196.

1971 Archaeology on Nukuoro Atoll, a Polynesian outlier in the Eastern Caroline Islands. *Bull. Auckland Inst. Mus.* 9: 1 - 108.

n.d. The individual fisherman's kit on Nukuoro: a comparison of archaeological and ethnographic evidence. Paper prepared for proposed Ethnographic Atlas volume on fishing. Typescript, 21 p.

EMORY, Kenneth P. and Yosihiko H. SINOTO

1965 Preliminary report on the archaeological investigations in Polynesia. Field work in the Society and Tuamotu Islands, French Polynesia, and American Samoa in 1962, 1963, 1964. Mimeographed, Honolulu. 108 pp. illus.

PA AND OTHER SITES IN THE PARUA BAY DISTRICT, WHANGAROA, NORTHLAND

AILEEN FOX

AUCKLAND INSTITUTE AND MUSEUM

Abstract. The settlement pattern in Parua Bay is discussed in relation to the topography and economic resources of the area. A regional type of fortification is defined and a method of estimating the population is suggested.

The fieldwork in Parua Bay was undertaken at the invitation of Mr Douglas Myers in order that the archaeological sites on his property were recognised and conserved. The area, known as Matauri Bay Farms Ltd., is shown in Figs. 1, 2. Eighteen sites were recorded (Fig. 2), consisting of six pa, seven open settlements with terraces, two pit groups and three areas of cultivation; there were also five terrace sites that were doubtful, bringing the total up to 23. Particulars of all these sites were given in a report to Mr Myers, which is available at the Auckland Museum Library and in the Anthropology Department of the University. The site numbers used in this article refer to the New Zealand Archaeological Association's site recording scheme.

The method of survey was to visit and plan the known pa which were either marked on the NZMS 1 map or else conspicuous in the landscape. The plans (Figs. 5-10) were done with a prismatic compass and pacing, and obviously contain minor inaccuracies. The intervening ridges and spurs were then walked looking for pits and other features and the land behind the beaches was carefully investigated; some bush-covered areas were omitted.

THE SETTING

The Matauri Bay property is situated on the rugged coastal tract, which extends from Whangaroa Harbour to the north-western head of the Bay of Islands; it faces the Cavalli Islands, four kilometres offshore to the north-east. It comprises the greater part of a peninsula, 2.5 km long to its northern extremity at Opounui Point, which lies between the open sandy Matauri Bay on the east to Whau Bay on the west (Fig. 1). The property boundaries however, follow the crests of the ridges and exclude the slopes to the Whau stream and to Matauri Bay (Fig. 2); the total area is approximately 343.98 hectares (850 acres).

The peninsula is of bold relief (Figs. 3, 4), comprising two main ridges 100-130 m high flanking the Parua stream, from which numerous lateral spurs diverge divided by short streams flowing to either coast. The chief of these are the Whau, Waimiti and Opounui streams which issue in small bays on the north-west coast. The Parua stream flows north to a stony bay, the principal inlet on the north-east coast.

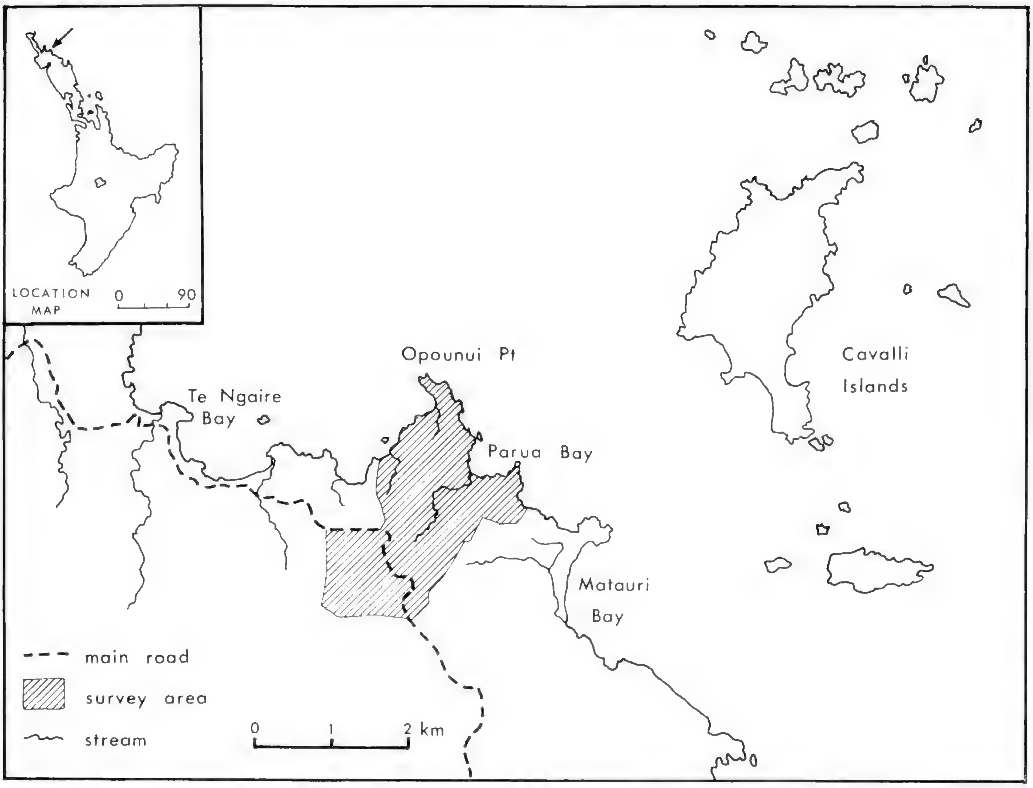


Fig. 1. Location maps, Parua Bay district.

Geologically, this is an ancient landscape; the underlying rocks are greywackes of the Waipapa series, a complex of folded marine sedimentary rocks formed in the late Paleozoic and early Mesozoic area (Ministry of Works N.Z. 1964, p.11 & Map 1). These are exposed dramatically in the sheer cliffs which ring the peninsula; the formation has weathered superficially to a soft sandstone "varying from a greyish orange to a reddish orange colour with cores of white very altered sandstone" (P. Moore pers. comm.). This in turn has broken down to a strongly leached yellow-brown earth of low natural nutrient status which varies from 0.5 to 1 m deep, or more when soil has accumulated as hill-wash on the lower slopes and in the valleys. The whole area will have been originally wooded with a mixed podocarp forest including kauri (Ministry of Works N.Z. 1964, p. 26), whereas today there are only patches of manuka scrub. Lemonwood trees *(Pittosporum eugenoides)* must have grown on Puketarata from which the pa (N8/10) was named.

From the point of view of the prehistoric Maori settlers, the area offered several advantages. It was within easy reach of good fishing grounds in relatively sheltered waters, and with a series of small bays where the canoes could be safely beached; there were a variety of shell-fish available in the sandy Matauri Bay and on the rocky coasts, as well as in the more distant Whangaroa Harbour; the climate and soils were suitable for cultivation of kumara (sweet potato) on the lower slopes when cleared of bush, and for taro on the flats by the streams. The

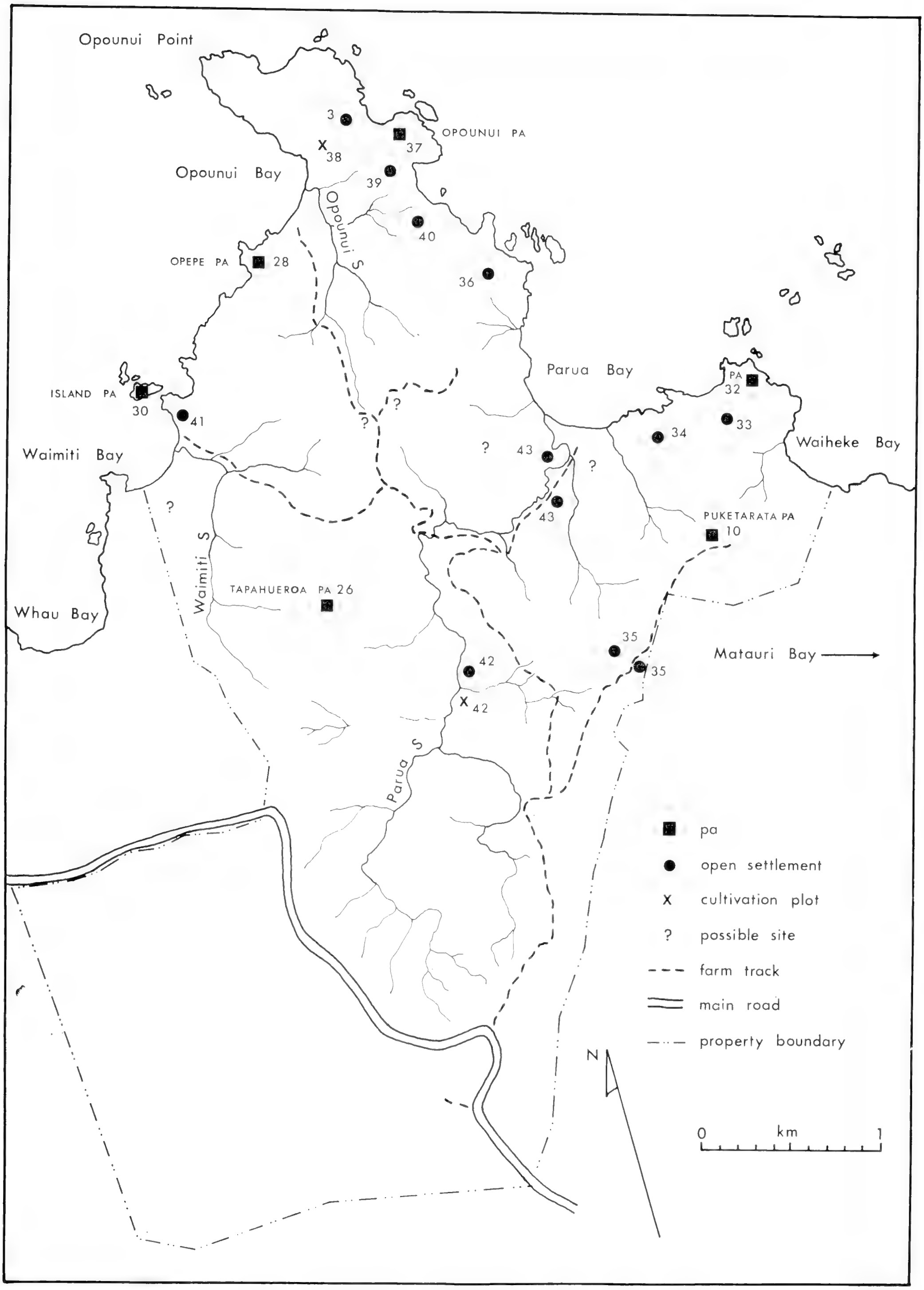


Fig. 2. The prehistoric settlement pattern in Parua Bay.

Fig. 3 Parua Bay, left, with Puketarata pa on the central summit: the Cavalli Islands behind. (Photo: A. Fox).

Fig. 4. Looking NE from Tapahueroa pa, towards Opounui pa. (Photo: A. Fox).

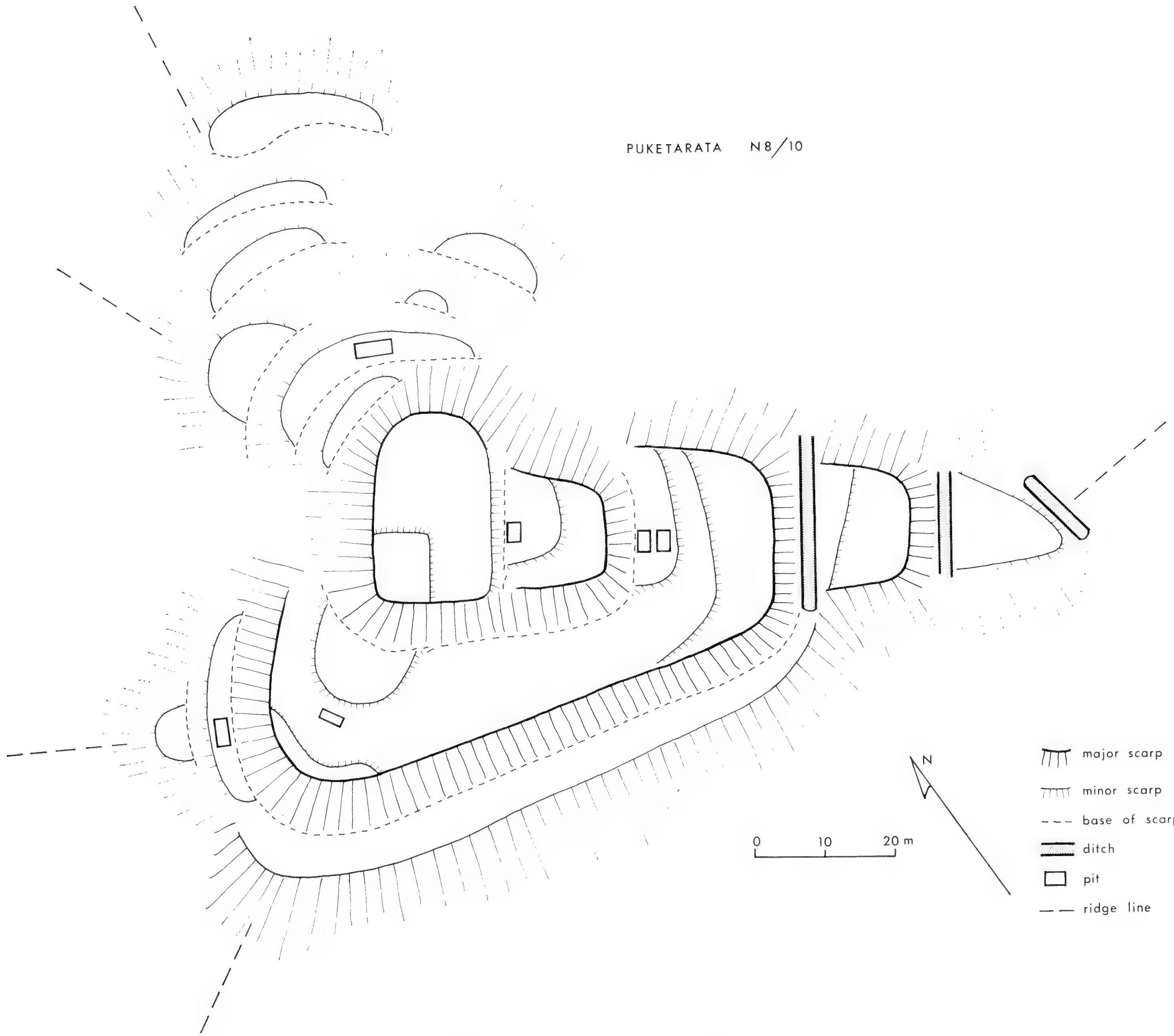


Fig. 5. Plan of Puketarata pa, N8/10.

relief offered a series of ready-made strong points for defence in case of attack. There is little wonder that the peninsula, now practically deserted except for holiday-makers, shows signs of formerly being densely settled.

The Settlement Pattern (Fig. 2)

The pa dominate the settlement pattern, the visible remains of terraced open settlements or pits or cultivation being small and slight. Puketarata pa (N8/10) (Figs. 3, 5) situated at a nodal point 91.5 m up on the ridge between Matauri Bay and the Parua stream is the largest, with the most sophisticated layout, and presumably the principal settlement in the district. Its defences, a series of three transverse ditches and scarps, were designed to bar an approach up the relatively easy slopes from Matauri Bay whilst the approach along the ridge from the south was flanked by two major scarps which almost certainly carried palisades. The pa could also be seen from Parua Bay from which it could be reached after a steep climb up either of two spurs; these were blocked at their summit by defensive crescentic terraces situated outside and below the main enclosure of the pa (Fig. 5). The pa interior is terraced and sub-divided by low scarps indicative of family living places, and culminates in a prominent rectangular summit platform or *tihi*. There are only seven small storage pits, implying that kumara cultivation was minimal, which is borne out by the few small-scale open sites in the surrounding area (N8/33-36) (Fig. 2). The inhabitants must have relied on fish supplemented by fern root for their main food supplies; the control of the beaches at Matauri and Parua Bay for fishing bases and canoes will have been essential to their economy.

The other pa (N8/32) in this area is of a different kind (Fig. 6). The precipitous headland north of Waiheke Bay was fortified by five close-set ditches with four intervening banks, defending only a small scarped area on the cliff top. The inner ditch continues down the southern slope towards a nameless little stony beach; there are four or five terraces on the slopes outside the defences and it is probable that the pa was constructed as a look-out and a refuge for small settlements (N8/33, 34) on the hill sides around the bay (Fig. 2). The use of banks and of multiple lines of close-set defences indicate a different tradition of fortification and suggest that this was the work of an intrusive group. Banks are a feature of the defences of some late Ngapuhi pa in the Bay of Islands, such as Kororipo at Kerikeri.

The block of land north and west of the Parua stream is dominated by the Tapahueroa pa (N8/26) (Fig. 7) on the highest point at 148 m. The defences, consisting of two magnificent scarps and a small transverse ditch with external bank, are aligned across the ridge in order to bar an approach from any landing in Whau Bay, which is not visible from the hill top. The interior of the pa is small, essentially a 20 x 16 m summit platform (*tihi*) divided in half by a low scarp, with crescentic terraces defending two subsidiary spurs; there is a block of twelve terraced store pits down the northern ridge. In essence this pa is a strongpoint defending a food store, and probably was a chief's seat. From the position of the store pits, it can be deduced that the crops were grown on the north facing slopes towards Waimiti Bay, though no traces of garden plots could be detected. At Waimiti Bay there are indications of a terraced settlement (N8/41) behind the

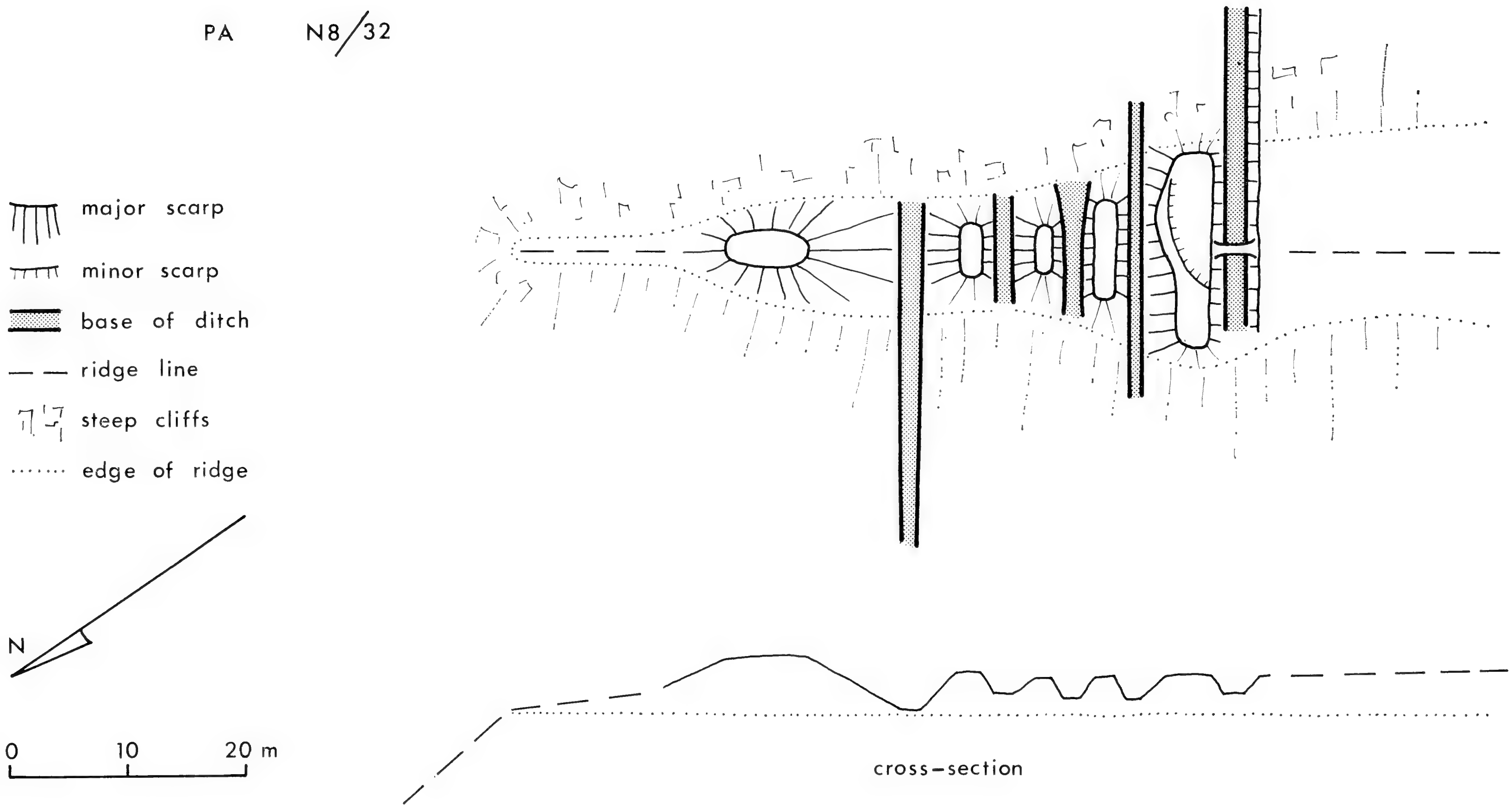


Fig. 6. Plan of headland pa, N8/32, north of Waiheke Bay.

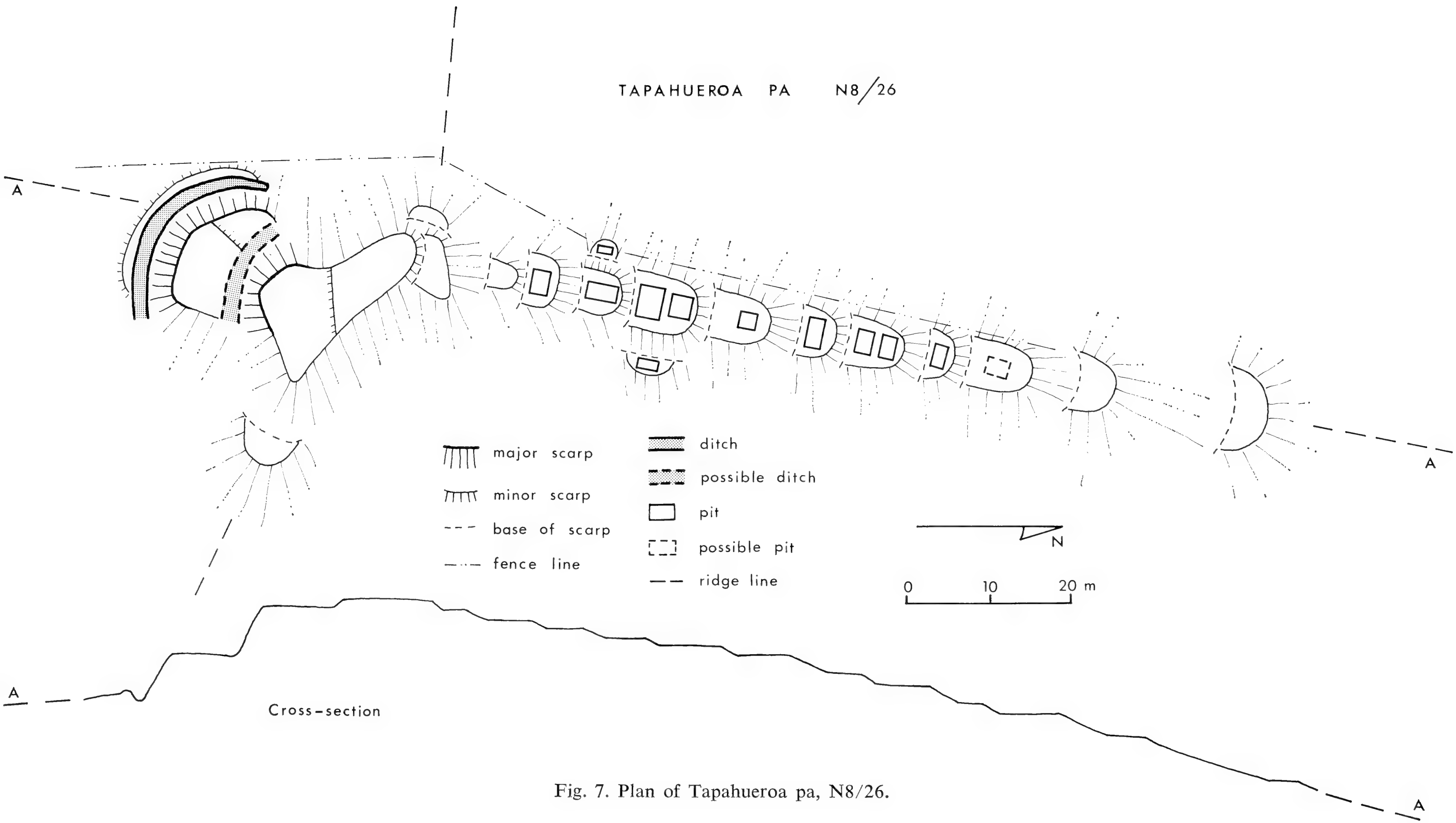


Fig. 7. Plan of Tapahueroa pa, N8/26.

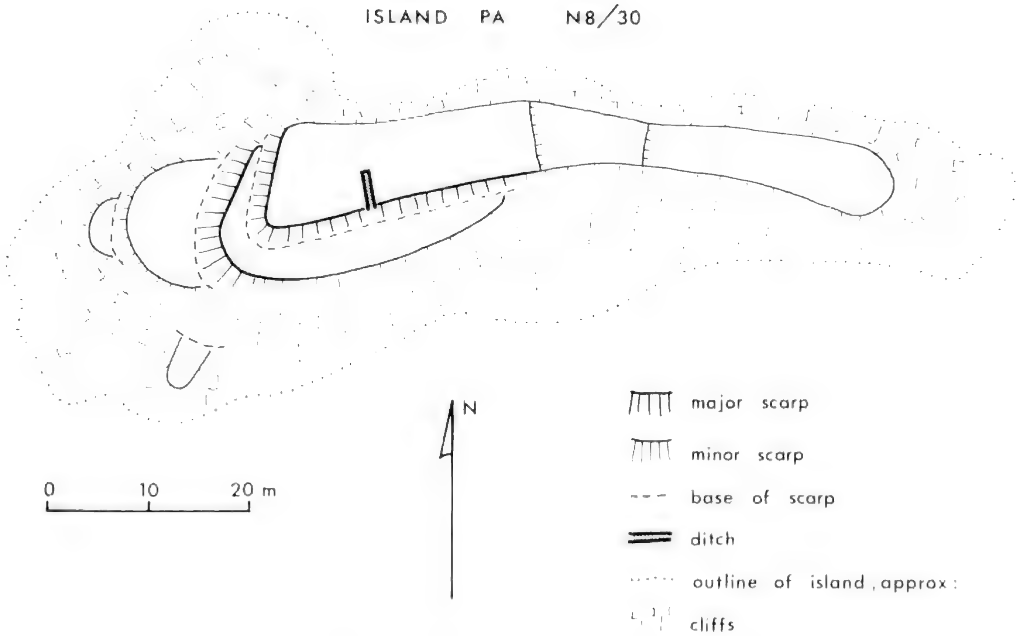


Fig. 8. Plan of island pa, N8/30, Waimiti Bay.

foreshore and also a small fortified settlement (N8/30) (Fig. 8) on the rocky island off the northern point. This island, which is accessible by a scramble at low tide, is naturally defended by cliffs on the north and east sides and by artificial terraced scarps on the south and west. A cooking area is apparent on the terrace at the west end. There is a short length of transverse ditch on the summit, probably incomplete. The island probably was a lookout as well as a fishing base for the people who built Tapahueroa pa, which dominates the skyline from the shore. Fishing from the rocks at the base of the island is still good today and the bay is also visited by the Maori fishermen for "sea eggs" (*Evechinus chloroticus*).

The third major fortification is Opounui pa (N8/37), situated on a bold headland on the north side of the peninsula (Figs. 4, 9). In design it resembles Puketarata and Tapahueroa in defending the only line of easy approach by a ditch with external bank and internal scarp. Terraced living areas on the summit also have defensive scarps, no doubt supplemented by palisades; the *tihi* is divided by a minor scarp and there are no obvious pits. This is the only pa that shows signs of alteration in the defences; the main ditch on the west side ends about 2 m short of the cliff edge, indicating an original entrance. A second smaller ditch has been dug to cover this gap 20 m farther west, continuing to the cliff edge, and ending 20 m down the slope on a pre-existing terrace (Fig. 9). It is clearly visible on air photographs. The present entrance to the pa is by a causeway across the main ditch 10 m from its western end and by a diagonal track up the scarps.

There are indications of several small terraced settlements with pits (N8/39, 40) and of terraced cultivation plots (N8/38) on the adjoining spurs and in the valley leading down to Opounui Bay, as well as a group of pits on the cliff top (N8/3, marked on the NZMS 1 map as Opipi pa). These take advantage of the comparative shelter of the north-westerly slopes and of easy access to the beach.

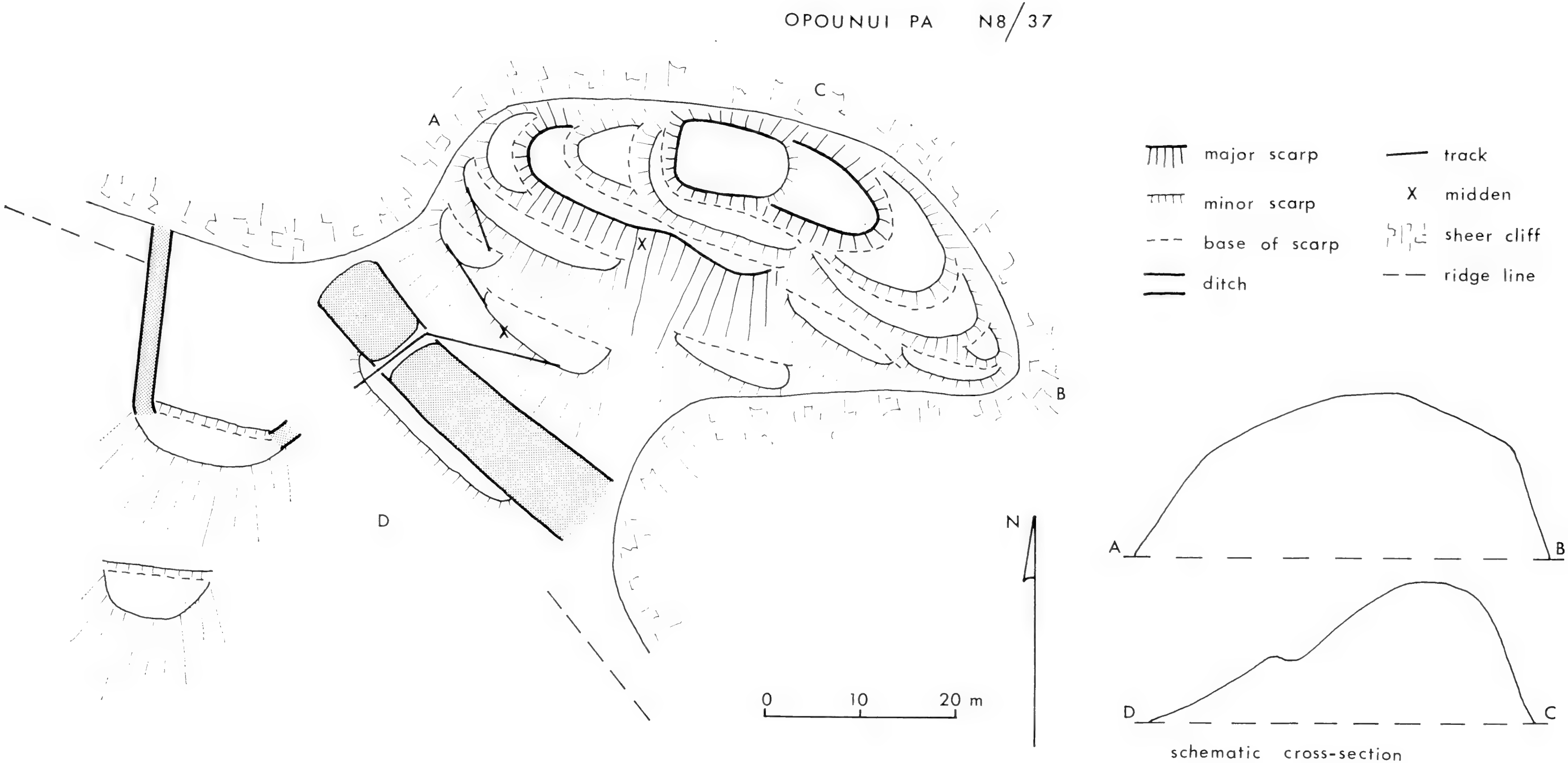


Fig. 9. Plan of Opounui pa, N8/37.

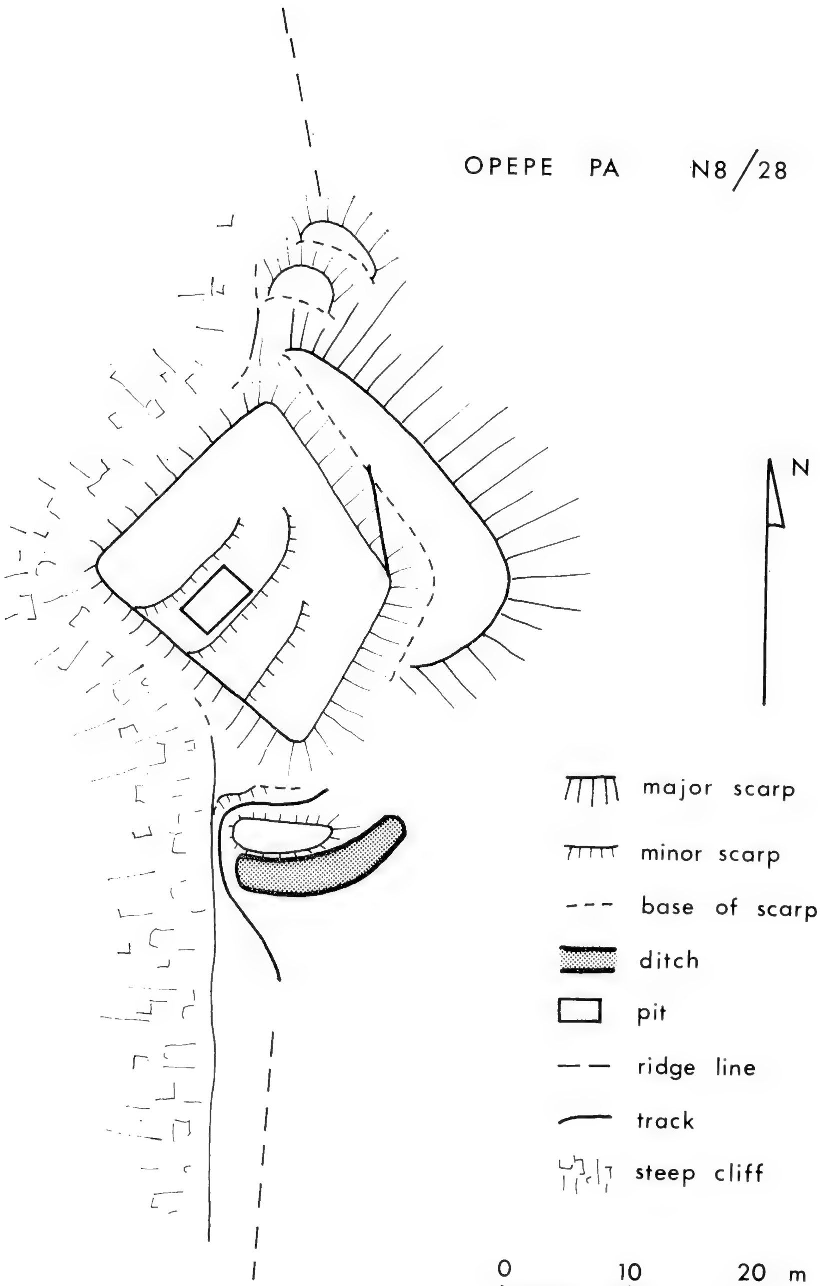


Fig. 10. Plan of Opepe pa, N8/28.

Opounui Bay was also available to the inhabitants of Opepe pa (N8/28) on cliffs at Marawhiti Point (Fig. 10). This is a smaller pa, with a square topped terraced summit platform with one large storage pit. The level approach from the south along the cliff tops is barred by a short length of ditch and an internal bank which is partly an eroded sandstone outcrop. The entrance resembles that at

Opounui, with the ditch stopping 1.5 m short of the sheer cliff and a worn rock-cut path round the end of the outcrop; this leads to a lower terrace and then diagonally up the intervening scarp to the summit platform. The absence of earthwork defence on the northern and western slopes to the beach suggests that the inhabitants had no fear of attack from the direction of Opounui. It may be deduced from this and from the constructional similarities that the two pa belonged to related groups, who shared the resources of the bay and the adjacent territory.

Population and the Economy

It is always difficult to know whether a concentration of settlements in a small area, such as is manifest at the Parua district, is broadly contemporary, and reflects a rapidly increasing population, or whether it represents a succession, built by a small group shifting about in the landscape over a long period of time. Such problems can only be decided after a prolonged campaign of excavation and perhaps not even then, in the absence of distinctive dateable artifacts. Some evidence in favour of contemporaneity has been produced from the field survey, in which it has been shown that five out of the six pa use similar methods of fortification. Each relies on major artificial scarps, almost certainly carrying palisades, and supplemented by short transverse ditches, sometimes with a low external bank, constructed solely on the easiest line of approach. The sites were selected with this concept in mind and were skilfully engineered to use the topography to its best advantage. Other details significant of a regional style are the design of the entrances at Opepe and Opounui which forced attackers to file round a ditch-end towards the cliff edge, and the small-scale division on the summit platform (*tihi*) seen at Puketarata (Fig. 5), Opounui (Fig. 9) and Tapahueroa (Fig. 7), which must be of some social significance. Only the headland pa at Waiheke Bay (Fig. 6) which was defended by a series of four close-set banks and ditches is built in a different style, suggesting an intrusive group.

A recent field survey by R. Cassels and J. Stevens for the New Zealand Historic Places Trust has shown that fortifications in the Parua style continue along the coastal tract to the north-west as far as Wainui Bay and occur also in the Tauranga valley, inland from the Whangaroa harbour; in these areas there is a dearth of pits and middens. Between Wainui and Tauranga the types of pa are more varied and include a few with lateral ditches and the pit groups are larger and more numerous (R. Cassels pers. comm.).

The distribution of the six pa in the Parua district (Fig. 2) is not unreasonable when it is considered in relation to the available food resources. It is apparent that each pa dominates and is accessible from a bay; Puketarata from Matauri or Parua Bays, Tapahueroa and the subsidiary island pa from Waimiti Bay, whilst Opounui and Opepe share access to Opounui Bay. The absence of large shell middens in the pa or near the coast imply that shellfish were not the major item in the diet and consequently protein is likely to have been obtained from fish. Sea fishing from canoes launched and landed at the bays will then have been of considerable economic importance; much of the catch would have been preserved by drying. Judging by Lesson's account (Sharp 1971, p. 58), of the nearby Bay of Islands, "Fishing expeditions are so pleasant and the fish so abundant that the natives give away enormous quantities for trifles", there would have been enough for all. It is also relevant that Captain Cook named the nearby Cavalli Islands from the trevalli fish sold to him there by the Maoris (Beaglehole 1955, p.213).

The relatively few kumara storage pits recorded in the pa and open settlements, 35 in all, (Tables 1, 2) implies that the amount of cultivation was limited, though suitable slopes were available. The substitute was fern root which K. Shawcross has shown was the staple diet in the North (Shawcross 1967, p. 330). J. L. Nicholas who landed with Samuel Marsden on this coast in December 1814, commented, (1817, 1 p. 142), "The fern is an invaluable production to these people who subsist in a great measure on the roots of it, from which they prepare a sort of bread. As it grows here in the greatest abundance, they may be always sure of an inexhaustible supply". With an economy based on fish and fern root, the Parua and neighbouring districts could have supported a growing population for a considerable period of time.

With these considerations in mind, a rough estimate of the maximum number of people, excluding children, has been obtained by counting the probable living terraces within the pa and in the open settlements (Tables 1, 2). There is, of course, the difficulty in deciding which terraces were purely defensive or how many were purely for storage and should be excluded, or how many houses were built on each of the larger terraces; in estimating, it has been assumed that these factors will tend to cancel each other out. Each terrace has been equated with an extended family group, with one dwelling holding six adults. This number is based

Table 1. Estimated adult population at pa sites.

Number	Name	Terraces	Summit (tihi)	Pits	People
N8/10	Puketarata	15*	1	5	98
26	Tapahueroa	6	1	12	44
28	Opepe	4*	1	1	32
30	Island pa	6	—	—	36
32	Headland pa	1	1	—	14
37	Opounui	12	1	—	80
Totals:	6 pa	44	5	18	304

*Two small defensive terraces have been excluded.

Table 2. Estimated adult population at open settlements.

Number	Terraces	Pits	People
N8/3	—	4	12
33	4	—	12
34	—	3	9
35	3	—	9
36	6	—	18
38	4	1	12
39	4	6	12
40	7	—	21
41	4	2	12
42	5	—	15
43	4	1	12
Totals: 11 settlements	41	17	144

Fig. 11. "A Hippah in New Zealand, Queen Charlotte Sound" by John Webber, 1771, showing a family group of six people on a house terrace.

on observation by Cook's artist, John Webber, as illustrated by his drawing of 1771, "A Hippah in New Zealand, Queen Charlotte Sound" (Fig. 11) which shows a family group on a terrace in front of a house. It is also the number mentioned by Cook's surgeon, W. B. Monkhouse, in his Journal as inhabiting a single house at Tegadu (Anaru) Bay, "Here was a man, his wife, two sons, an old woman and a younger who acted as servants" (Beaglehole 1955, p. 584).

The chief might be expected to have a larger household; Augustus Earle (Murray-Oliver 1968, Pl. 26) drew a retinue of twenty people surrounding the dying Paramount chief Hongi, including his two wives. For a lesser man, eight adults seems a reasonable figure to be housed on the summit platform or *tihi* and has been employed in the estimate. In the open settlements, living quarters would be less congested and only half the terraces are likely to have been used for housing, and the others for storage and the practice of crafts and manufactures; consequently, an average of three people per terrace has been adopted in the calculations. This is compatible with J. L. Nicholas' description in 1814 (1817, 1 p. 258) of "a family living entirely by themselves, remote from any village and in a perfect state of seclusion". It consisted of "a man with his head wife, two subordinate ones and three or four very fine children". Excavations near Aotea Harbour by Richard Cassels revealed one house structure in a group of three terraces (pers. comm.), whilst on Mototapu Island Anne Leahy found a house associated with two terraces and two storage pits (Leahy 1972, p. 24).

It is admitted that these calculations are rough and ready and applicable only to areas where the pa interiors are terraced. Obviously the yardstick could

be elaborated or refined but a sound alternative could only be produced after the total excavation of a pa or at least of the full range of its salient features. On the present basis, it appears that there could have been 304 people living in the six pa and 144 in the open settlements, or about 450 adults in all. This does not sound unreasonable for a probable peak of population in the late 18th century and could be an underestimate. J. L. Nicholas (1817, 1 p. 177) estimated the inhabitants of Rangihoua pa in the Bay of Islands in 1815 at 150-200; later (1817, 2 p. 298) he commented that most other village settlements contained only 20-30 people.

The Maori people in the district today are Ngapuhi but when the first Europeans arrived it was border country with the Ngati Kahu. Samuel Marsden, with Hall, Kendall and Nicholas landed on this stretch of coast in December, 1814, on their way to the Bay of Islands. It is not possible to pin-point their actual landing place from the brig "Active", which was anchored off the Cavalli Islands, "one league from the mainland and five leagues from Whangaroa harbour" (Elder 1932, p. 85), though Matauri Bay has been suggested. It was claimed as his territory by Chief Hongi of the Ngapuhi who was then on board the "Active" but there was a visiting party from Whangaroa camped on the shore under their chief "George" (Te Ara or Tiara) who had come to attend the funeral of a local chief (Elder 1932, p. 86). Marsden's object in landing was to make peace between the two people who had been at war since the Boyd massacre of 1809. This may have been the outcome of a long period of tension between the two peoples, which in turn is reflected in the building of the numerous fortified settlements on this part of the coast. Another people in the area may have been some of the Ngati Uru, who had recently migrated to the Whangaroa area from the southern part of the Bay of Islands after the killing of Marion du Fresne in 1770 (Smith 1897, p. 13); it is tempting to see their work in the headland pa (N8/32) north of Waiheke Bay, which is fortified in a different style from the others in the district.

Acknowledgements. I am grateful to Mr D. Myers for the opportunity to undertake a close study of a small but rewarding area. The week's fieldwork was carried out with the expert assistance of John Coster and Gabrielle Johnson: Mr Coster was responsible for the initial plans which have been redrawn by Caroline Phillips. We were indebted to Mr Myers for accommodation in his caravan at Parua Bay and to his farm manager, Mr T. Parker, for his co-operation. Mr S. Bartlett, the New Zealand Archaeological Association file-keeper for Northland, kindly supplied air-photographs and his notes on the area, whilst Richard Cassels and Julie Stevens provided information of sites in the neighbouring Whangaroa district. I am indebted to Mr D. Simmons for the reference to W. B. Monkhouse's Journal.

REFERENCES

BEAGLEHOLE, J. C.

1955 *Journals of Captain James Cook.* I. Hakluyt Soc., Cambridge.

ELDER, J. R. (Editor)

1932 *Letters and Journals of Samuel Marsden.* Coulls, Somerville & Wilkie, Dunedin.

LEAHY, Anne

1972 Further excavations at site N38/30, Motutapu. *Rec. Auckland Inst. Mus.* 9 : 15-26.

MINISTRY OF WORKS N.Z.

1964 *National Resources Survey Pt. III, Northern Region.* Compiled by the Town and Country Planning Branch, Ministry of Works. Government Printer, Wellington, N.Z.

MURRAY-OLIVER, A.
1968 *Augustus Earle in New Zealand*. Whitcombe & Tombs, Christchurch.

NICHOLAS, J. L.
1817 *Narrative of a Voyage to New Zealand*. 2 vols., facsimile. Wilson & Horton, Auckland.

SHARP, A. (Editor)
1971 *Duperrey's Visit to New Zealand in 1824*. Turnbull Library, Wellington.

SHAWCROSS, K.
1967 Fernroot and the total scheme of 18th century Maori food production. *J. Polynes. Soc.* 76 : 330-352.

SMITH, Percy
1897 The peopling of the North. *J. Polynes. Soc.* 6 Suppl. : 1-108.

WHAKAMOENGA CAVE, TAUPO, N94/7

A report on the ecology, economy and stratigraphy

ANNE LEAHY

AUCKLAND

Abstract. Whakamoenga Cave was excavated by Trevor Hosking between 1961 and 1963. Eleven layers were established. A variety of faunal and botanical material together with artifacts was found. The layers have been grouped into three occupations on the basis of a major rockfall, a renewed occupation and the appearance of European artifacts.

Occupation 1, the earliest, contained cultural material, moa bone, the remains of numerous birds, especially bush birds, and a considerable amount of flaked obsidian. It is dated by Carbon 14 to the fourteenth and fifteenth centuries. Occupation 2 occurred after a major rockfall, which sealed off the earlier occupation. Fewer bush birds were present, suggesting considerable forest destruction had occurred. Numerous obsidian flakes were present. Carbon 14 dates suggest late seventeenth century age. Occupation 3 is represented by the four top layers. These contained artifacts of European origin. Carbon 14 results indicate that these deposits were laid down during the nineteenth century.

Whakamoenga Cave is an inland archaeological site situated on the northern shore of Lake Taupo (Figs. 1, 2). It was dug by Trevor Hosking, assisted at various times by myself and others, between 1961 and 1963. In his preliminary report on the excavation, Hosking (1962, p. 22) describes the site in detail:

> [Whakamoenga Cave] is a large cave a few chains from the lake edge at Whakamoenga Point on the north-eastern shore of Lake Taupo (N.Z.M.S. 1:25,000, N94/7, 483317). The Point is the southern-most of the land-mass that forms the western shore of Tapuaeharuru Bay on which the town of Taupo is situated. The site is 1200 feet above sea level. The cave has a high arched opening to the S.E. and a smaller opening to the S.W. The front or S.E. opening is some 15 feet high and 30 feet across to where a rock column separates a further small entrance to the western chamber of the cave. The ground in front of the entrance is level for about a chain and rises up some 6 feet to the entrance, when it then slopes down gently into a hollow in the centre before rising again at the rear. To the left of the entrance are two rocks that appear to rest on the surface. Behind them and occupying most of the western chamber are further rocks of considerable size taking up most of the floor space. In the main gallery one large rock (14) projects above the floor and tops of others are just visible in the surface dust. To the north-east there is a further low chamber some 5 feet by 18 feet that runs back into the rock for a further 30 feet.

Fishermen had drawn Hosking's attention to the cave and when a road was put in to Whakamoenga Point by the owners to allow access for building on the flats above the cave, investigations were made to find out something of the history and previous ownership of the land. This included research with Maori elders, local people and the Department of Lands and Survey. Permission to excavate was obtained from the owners, Mr Butler and Mrs Gower, and work commenced in December, 1961.

One translation of the name "Whakamoenga" is "the sleeping or resting place". It appears to be an old name in the district (Hosking, pers. comm.) and the archaeological evidence tends to support this description.

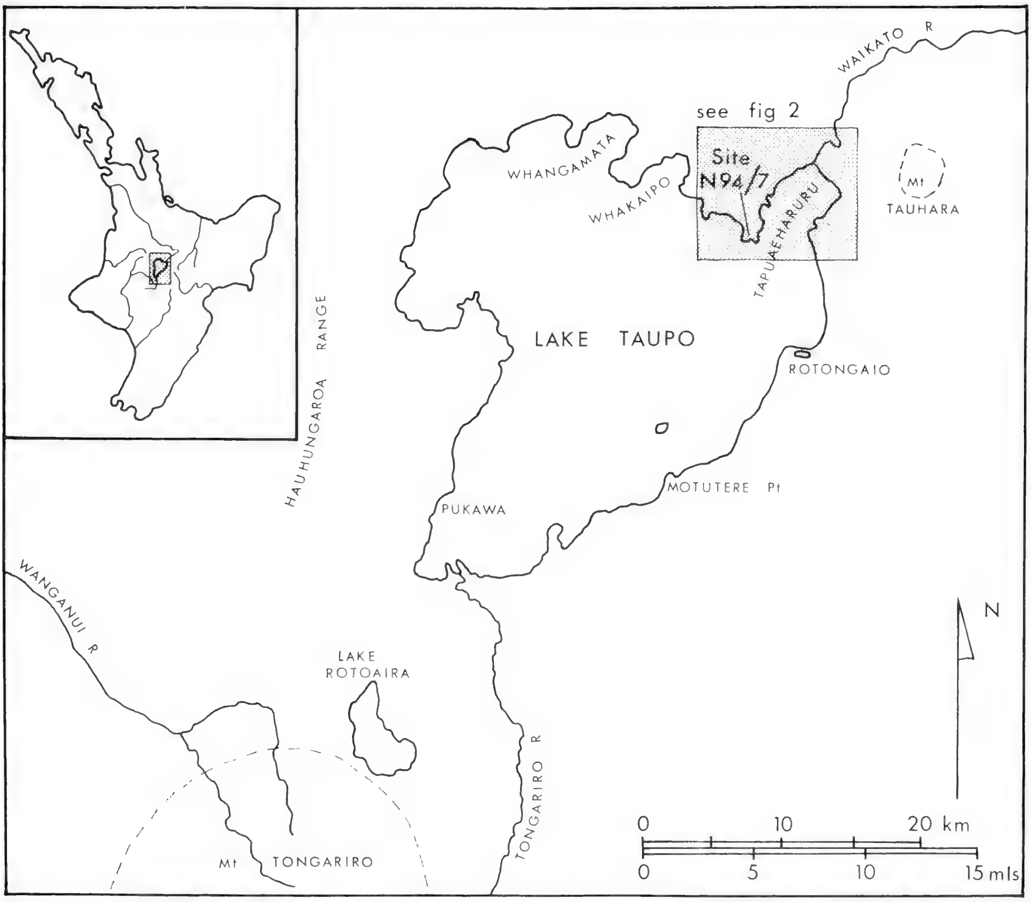


Fig. 1. Map of Lake Taupo area.

General Geology and Land Formation

The central volcanic plateau from the Bay of Plenty to south of Taupo was formed by accumulations of volcanic rhyolite rock. Into this plateau, geological faults have created upthrusts and downthrusts. These are especially noticeable in the Taupo area in the land formations along the northern and north-eastern sides of the lake. Whangamata, Whakaipo and Tapuaeharuru Bays (Fig. 1) are the remains of series of these up and down thrusts, and the peninsulas between them include the one whose western tip forms Whakamoenga Point and eastern tip, Rangatira Point (Fig. 2). These faults are still active (National Resources Survey 1962, pp. 456-67).

The sheer ignimbrite cliffs at the southern end of the Western Bay of Lake Taupo are probably the result of a caldera formed by a collapse after an eruption of magma prior to the Taupo Ash Shower.

Studies by soil scientists and geologists of the thick deposits of pumice that surround Lake Taupo have shown that in the past 10,000 years many eruptions of great violence have occurred near the eastern side of the lake. The latest of

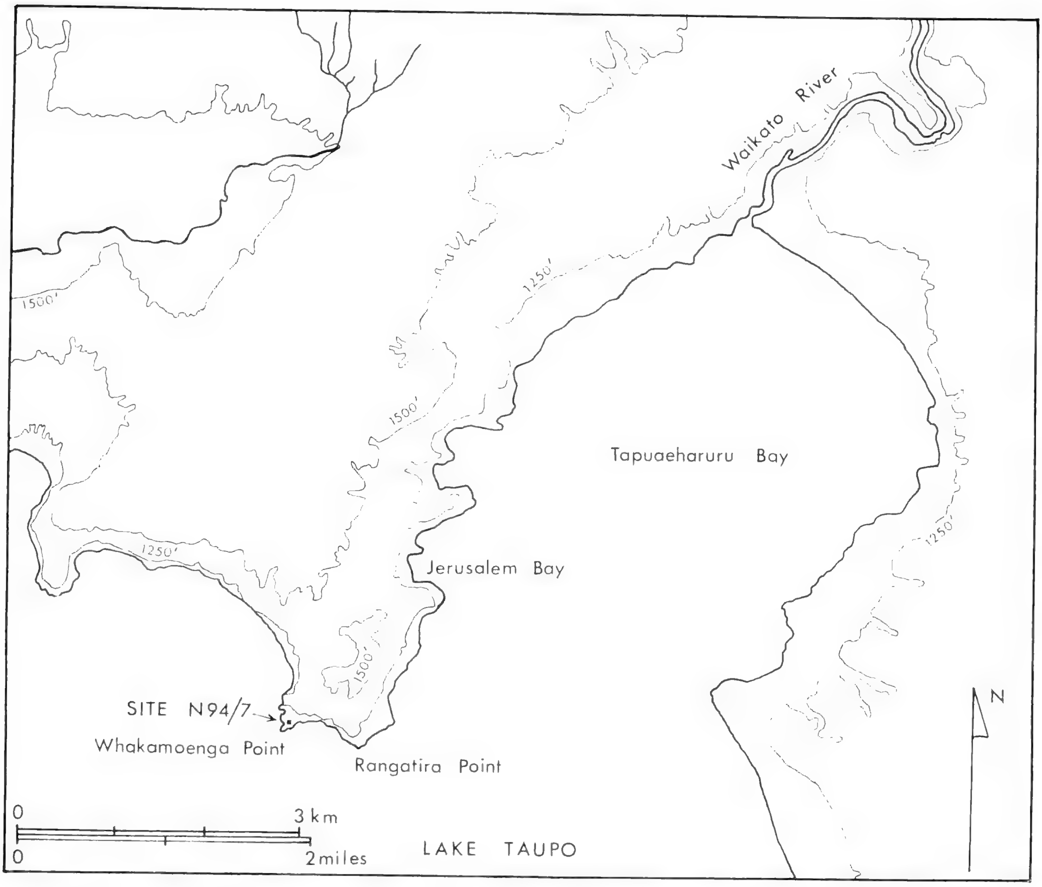


Fig. 2. Site N94/7 and surroundings.

these eruptions took place about 1800 years ago. Recent radiocarbon datings, representing a pooled date from several apparently close eruptions, place this activity at about 1819 ± 17 B.P. (Healy *et al.* 1964, p.34). These last eruptions form part of what are known as the Taupo Ash Showers. They began with a series of huge explosions of mounting intensity that spread pumice ash over the entire middle part of the North Island, destroying much of the forest and vegetation around Lake Taupo. Explosions occurred at Waitahanui and Hatepe. At Rotongaio, a vent opened at the side of the Rotongaio lagoon, eventually forming a swampy area. Later, large blocks of rhyolite and coarse pumice were deposited over the Taupo area. Boulders from this explosion litter the shores of Lake Taupo between Waipahihi and Rangatira Point. The eastern side of the lake, owing to the nature of the showers, presents a much less spectacular terrain and the land slopes gradually from the shore towards the Rangitaiki Plains.

Where the terrain is not formed by ignimbrite, cliffs occur at the 110 foot (33 m) level around the lake representing an old lake height which later fell to the present level (1150 ft, ca. 350 m a.s.l.).

The north-eastern end of the lake has been blocked by the small volcanic cone of Mt Tauhara and thick deposits of pumice breccia. This has been breached

in one spot by the mouth of the Waikato river, between the base of Mt Tauhara and the fault line that forms the north side of Tapuaeharuru Bay.

The land to the north and west of the cave for a radius of 10 km consists of steepland soils and eroded Taupo ash. To the north-east the terrain flattens out as it nears the mouth of the Waikato River. Across the river and to the east of Mt Tauhara and Waitahanui are the eroded plateaus and gullies that rise gradually up to the Kaingaroa and Rangitaiki Plains.

Climate and Rainfall

The northern Lake Taupo area has a rainfall of less than 50 inches (ca. 1200 mm) of rain a year and it can be very dry between September and April and exceptionally dry about one year in four. Meteorological average readings for the period 1949-1970 show an average maximum January temperature of 23.4°C and a minimum of 10.8°C. The July temperature can range between 10.9°C and 1.7°C. Frosts occur at any time and can average 20-40 per year. Tender vegetation may be affected even in summer.

The erratic temperature and rainfall variations would make the growing of crops very marginal in the area and, although Governor Grey (Cooper 1851, pp. 290-92) talks of vegetable gardens at Pukawa in 1850, dependence on their regular growth would not be possible. Bidwill (1841) generally does not mention crops and talks of the cold throughout his visit in January and February.

Forest Regeneration after the Taupo Ash Shower

Although Holloway (1954) suggested that the instability of many South Island forests was associated with recent climatic oscillations resulting in a redistribution of species and the development of new forest types, this may not apply equally to North Island forests. The central North Island, and the Taupo area especially, with its series of major eruptions up to ca. A.D. 120, has confused and concealed a maze of readjustment patterns, arising not only from climatic variation but also from extensive volcanic cataclysms.

These ash showers and flows left a huge expanse of ash and raw pumice around Lake Taupo. Its exact extent and destructive effect on the indigenous forest is not fully understood but it is thought that a series of readjustment processes would have begun mainly from the forest to the west of the lake (in the Hauhungaroa Range area and north of it) that were not destroyed by the ash showers. Possibly a small remnant on the north and east side of Mt Tauhara may also have contributed parent forest in that area (I. Atkinson, pers. comm.). Tussock and fern colonized the pumice first, followed by manuka scrub and the scrub hardwoods, such as *Pittosporum, Pseudopanax, Weinmannia* etc. tolerant of these skeletal soils. Many of the fruits of these trees are attractive to birds and there would have been an invasion of pigeons, tuis and parakeets, bringing podocarp seeds that would be deposited in droppings. Regeneration would have been irregular but with a general west to east direction (McKelvey 1963, p.11). The forest would first have been re-established at the periphery of the zone of forest destruction and then have proceeded towards Lake Taupo. These distinctive types of lower altitude forests fall into three main groups; the dense podocarp forests, the matai/rimu forests and the northern rata/tawa/rimu forests.

The dense podocarp forest, representing the pioneering stage in the centripetal colonization of the sterile pumice, was gradually replaced by the other types of forest with increasingly prominent hardwoods. It is probable that the pioneering podocarps were nearest to the lake by about A.D. 1200 but regeneration would have been irregular.

This irregular distribution of forest with its skirting scrub hardwoods separated by open areas of tussock and fern would present an ideal situation for all types of bird hunting and foraging as well as allowing easy access between the forests, where the rugged terrain would allow it.

Atkinson (pers. comm.) suggests that:

> . . . all the remnants of the 'new forests' that we have been able to find show a 'first generation structure' and therefore their age is unlikely to be greater than 600-800 years from the present. This takes us back only to A.D. 1200-1400. So we are left with two options:
>
> (i) an unknown factor prevented the development of forest in the tussock and shrubland that would have covered the ground following the Taupo eruption. One would have to argue that this unknown factor operated over a period of 1000-1200 years.
>
> or
>
> (ii) there were frequent and/or extensive fires between A.D. 120 and 1200 which destroyed most or all of the original forest that developed on the Taupo pumice thus resulting in the present forest remnants being no more than 600-800 years old.

Atkinson favours the second explanation. The causes could have been natural combustion, occurring in a climate perhaps dryer than now, or careless or deliberate burning-off by man.

He suggests that there could have been a first and second generation forest in the north-west and north-east of the Taupo area between A.D. 950 and 1300 and that it would probably have consisted of dense stands of podocarps, particularly rimu, matai, totara and miro. Following its destruction by fire, the forest would have been replaced by kamahi forest (kamahi can sprout from stumps after fire) and manuka or kanuka scrub. Kamahi leaves are present in the botanical remains found in the cave throughout the occupations and the tree is still present near the cave today (see Table 4).

The earliest occupation (Occupation 1) in the cave was marked by the large number of bush bird bones and this, together with the Carbon 14 dates for this occupation, could fit in with the evidence of bush in the Lake Taupo area and its subsequent destruction. Atkinson suggests a date of up to about A.D. 1300, at least for the initial burning off and, if the Carbon 14 dates for Occupation 1 are interpreted at the earlier rather than the later end of their range, this general date seems reasonable. However, evidence from the cave indicates that bush birds were still important until the end of Occupation 1, period 2, and that a fifteenth century date for this period was equally possible. The number of forest birds associated with Occupation 1 might indicate that some forested areas were not destroyed as early as the general botanical evidence suggests.

Traditional Evidence

The early traditional evidence for the Taupo area is vague and confusing. Grace (1959) divides his book "Tuwharetoa", based on the Maori settlement of Taupo, into three periods:

1. Traditional history to the end of the seventeenth century.
2. Eighteenth century and first half of nineteenth century.
3. Latter half of nineteenth and twentieth century.

In his early period he tends to follow the "Fleet" traditions of scholars such as Percy Smith (see Simmons 1969) but his two later periods are from more recent traditions and history and are, therefore, probably more accurate.

According to Grace (1959) and Stafford (1967), Ngatoroirangi visited the Taupo area some time after the Arawa canoe landed in the Bay of Plenty. Also associated with his explorations was Tia, after whom Atiamuri, the Aratiatia Rapids and Lake Taupo-nui-a-tia were named. While visiting there they came in contact with a large tribe, the Ngati Hotu, together with another "pre-Fleet" group, the Ngati Ruakopiri. The Ngati Hotu held domain over Taupo and lands extending south-east almost to Hawkes Bay.

Of these aboriginal tribes Grace (1959, p. 80) states:

> Unfortunately there are no traditions that will assist in accounting satisfactorily for the origin and distribution of the ancient tribes which the fourteenth century immigrants found established. Maori tribal history must be pieced together very largely, if not entirely, from the traditions of those who survived the warfare and struggles incidental to the clash of the invaders with their predecessors.

The Ngati Hotu were eventually defeated by a group of tribes, one amongst whom claimed Tuwharetoa as their eponymous ancestor. Of these traditionally early battles Grace (1959, p. 117) talks of that between Kawhea, son of Kurapoto of Te Arawa canoe, and the Ngati Hotu and the Ngati Ruakopiri.

> When they [Kawhea's group] reached where the township of Taupo now stands they went over to Rangatira Point and attacked and captured three strongholds, Ponui, Te Kirikiri and Maunganui a Wawatai. Ponui Pa was on Rangatira Point itself; Te Kirikiri was on a low spur jutting out in the lake about three miles from Taupo; and Maunganui a Wawatai was situated on the high bluff at Whakaipo.

Kawhea continued on, but two groups stayed and concentrated their attention on lands about Taupo. They paved the way for the sons of Tuwharetoa who followed them to those parts several generations later. The two groups finally settled about Rangatira and the country extending to Rotongaio (Fig. 1).

Another tradition of the early period refers to a war party from the Mangakino area who journeyed to the southern part of Western Bay, later going on to Rangatira Point. There again the stronghold of Ponui was attacked. This pa may still be seen.

In Grace's middle period another palisaded pa, Omaunu, also situated in the same area, was the scene of fighting during the time of Te Heuheu Tukino (later killed by a landslide in 1846). From then onwards, the Rangatira peninsula is frequently mentioned in the protohistoric and historic records.

From these traditions it seems that the Whakamoenga-Rangatira area was in a crucial strategic position at the head of the lake from early times. These traditional activities should be reflected in Whakamoenga Cave, which is less than 800 m from Rangatira Point.

A broken pumice patu in Occupation 2, one in Occupation 3 (Figs. 16, 17) and traces of muskets and musket balls seem to indicate that the last two occupations may well reflect Grace's protohistoric and historic evidence for power struggles and warfare in the area.

Historical Records

The first European on record to visit Taupo was the Rev. T. Chapman who established a mission station at Rotorua in 1835. He spent a short while there in January and February, 1839. Three weeks later J. C. Bidwill (1841), having stayed with Chapman at Rotorua, set out for Taupo. He was warned to make enquiries about procuring a canoe to take him across the lake as there would be difficulties getting one. Arrangements were made during the journey and Bidwill eventually arrived on the shores of Taupo. Later, he had to scramble along the cliffs at the side of the lake for about a mile to the area where the canoe was (probably Rangatira Point). The next day (Bidwill 1841, p. 36):

> We embarked on Towpo about five in the morning, in a very large Ti-wai or canoe, hollowed out of a single log of wood, without top sides; those with top sides, of which they have none on this lake, are called Wa-kaw . . . This canoe was the largest of the kind I had seen; there were seventeen paddlers and about ten idlers, beside a great quantity of potatoes and my luggage. We had plenty of room, and for the first few miles went on very well. We had to cross a large bay, the only dangerous portion of our journey and till that was done I had nothing to complain of in their pulling. After that they fell off sadly. As the wind almost always blows off the east shore, we kept close under it in case of accidents; the morning was, however, very calm, and the lake as smooth as glass . . .

About eleven o'clock they arrived at a village which appears to have been Motutere (Fig. 1) having taken six hours on the journey there.

Bidwill remarks on the barrenness of the land, the steady diet of potatoes and the lack of firewood and timber. He also suggests that the land was covered with fern and became infertile because of the constant fires of a careless nature rather than because it had been cleared for agriculture but he makes no comment that this burning off might be associated with fern root production. Colenso (1880, p. 3) states that bracken fern was often burnt off in August to get the best root growth although this was a general statement about Maori food rather than one specific to Taupo.

Bidwill also comments on various plants, animals and minerals being used by the Maoris during his journey. Potatoes were growing near Taupo but these were of poor quality; a group were catching " . . . crawfish, shell-fish etc. and snaring ducks and shags, which were very abundant", in the Waikato River (1841, p. 31). Later, he saw people "making flax" which grew near the river in great abundance. Kokowai (red ochre) was being made from a mineral spring (1841, p. 35) and obsidian was common near the lake but he did not see any *in situ*. Evidence for the presence of all the above articles, except potatoes, was found during the excavation.

Although Bidwill did not comment on the use of fern root in the Taupo area, others who visited a short time later mention that it was an important item in the native diet. Cooper (1851, p. 266) who accompanied Governor Grey in a journey overland from Auckland to Taranaki in the summer of 1849-50, talks of their party being besieged by a host of wretched, ill-clad and half-starved inhabitants of Rangatira who had been living on fern root for some time. Later, Grey's group attended a feast prepared for them at Pukawa that consisted of kits of pork, kumara, potatoes, taro, calabashes of pigeons, kaka and tui preserved in oil and piles of dried fish. After which (Cooper 1851, p. 280), the Maoris: " . . . proceeded to dessert, which consisted of fern root roasted and beaten . . . The guests sat in a semi-circle in front of the slaves and as fast as the latter could beat the root and throw it to the former, so fast did they demolish it, apparently with great gout."

Cooper also mentions the beautifully kept cultivations at Pukawa, with about 300-400 acres (121-162 ha) under crops, producing several different kinds of wheat, potatoes, kumara, taro, pumpkins, maize, melons etc. in great abundance. This reference to pumpkins and melons growing at the southern end of Lake Taupo is interesting because *Cucurbitaceae* seeds were found during the excavation in the cave (see below, pp.56,63).

Percy Smith (Taylor 1959, p. 364) on his trip to the central districts in 1858, mentions that as they neared Pukawa they " . . . found an old woman who had come to grow fat upon fern root." Although Bidwill suggests that potatoes were the staple diet of the Maoris during the middle of the nineteenth century, other observers in the same areas suggest that fern root was also a staple.

Rangatira Point appeared to be a setting off or landing place for canoes travelling across the lake in historic times. Henry Williams in 1840 (Rogers 1961, p. 472) travelled from Motutere to Rangatira Point, which he describes as a very confined place upon a point projecting into the lake. Governor Grey (Cooper 1851, pp. 256-74) in his 1849-1850 trip left the point to go south. His party took 3¾ hours to cross Motutere, about 13 "lake miles", and a further 3½ hours to reach Pukawa some 12 miles (19 km) to the south. This trip seems to have been faster than that of Bidwill (who took six hours to get from Taupo to Motutere). It appears that it was possible to go, by paddling in fairly calm water, about 25 miles (40 km) in approximately 7¼ hours, following across Tapuaeharuru Bay to the eastern shore near Rotongaio, down the coast to Motutere and then on to the southern tip of the lake.

Most travellers mention the fear that the natives had of venturing too far out from the shore, because of the treacherous nature of the lake with its sudden changes of mood. Unfortunately, there are no records of trips around the Western Bays which might give some indication of the problems involved with water transport in that area and the collection of Whangamata obsidian, which is found in some quantity in the cave. If, as Bidwell suggests (1841, p. 36), the canoes on Taupo were only "dugouts" with no side strakes they would not be very seaworthy if the lake should become rough. Records suggest that long canoe trips on the lake were only undertaken during fine weather.

It is interesting to speculate what effect the shortage of good timber near the lake might have had on the building of strong or more "seaworthy" canoes

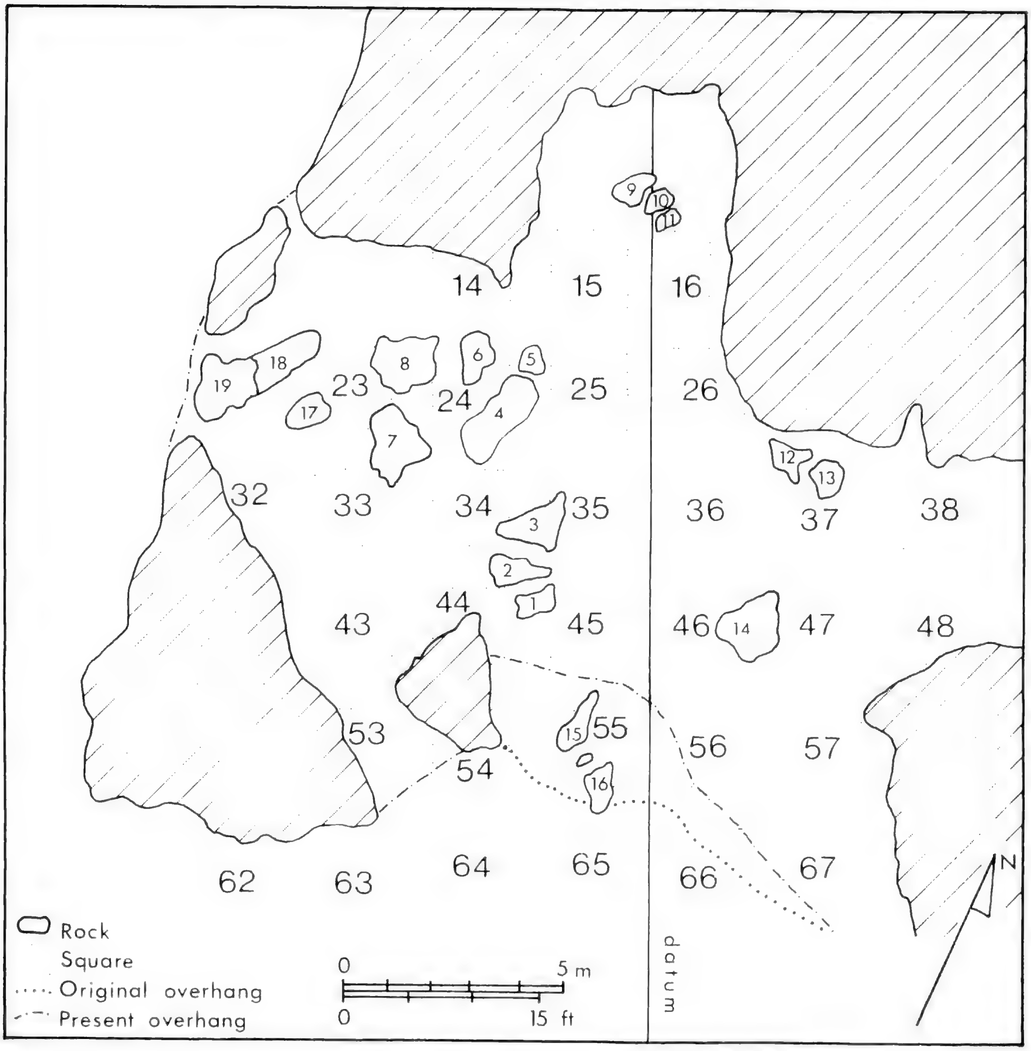


Fig. 3. Cave site plan and grid lay-out, N94/7.

after the disappearance of the forest. Historic accounts suggest that canoes were not readily available, yet to have access to one would cut the travelling time around the lake from about three days to one, and the people owning such a commodity would be at an economic advantage. The Rangatira locality appears to have been too inhospitable to recommend it as a settlement area but its geographic position, if combined with offering a service in the form of water transport, might well account for its importance in later times.

The Excavation

The setting out of the site is discussed by Hosking in his preliminary report (1962). A 9-foot (2.7 m) grid was set out, based on a central datum line running south-east/north-west from the front to the back of the cave (Fig. 3). Squares 5, 6, 13, 14, 54, 62, 63, 64 and 65 were not excavated. Only parts of squares 55 and

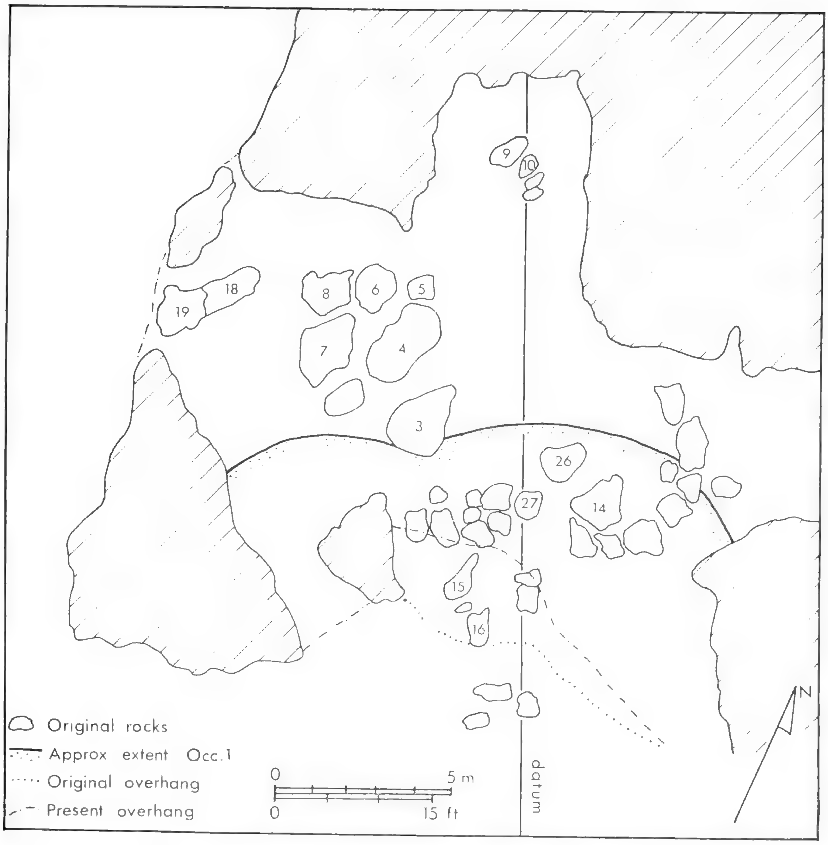


Fig. 4. First occupation floor plan, N94/7.

66 were dug because trees were growing in them and the owners had requested that the original appearance of the cave be preserved as far as possible.

Within the 9-foot squares, smaller 6-foot (1.8 m) squares were measured off, leaving 3-foot (0.9 m) baulks. Throughout this paper, the term baulks will refer to the 6-foot faces of the excavated squares, as shown by the section drawings. However, in some places it will be necessary to discuss the boundary lines between the 9-foot grid squares and these will be referred to as baulk boundary lines.

The deposits were excavated by hand trowel and sieved through $\frac{1}{8}$ in. and then 1/16 in. (ca. 3 and 1.5 mm) sieves.

Hosking's original labelling of the baulks in each square was A-B, B-C, C-D and D-A but, for clarity, baulks and baulk boundary lines have been renamed according to their compass directions so that A-B becomes north-west, B-C north-east, C-D south-east and D-A south-west. The south-east baulk is the side of a square nearest to the cave entrance.

The cave floor (Fig. 3) occupies an area of about 1800 ft^2 (167 m^2). Much of this was uninhabitable due to rocks or the lowness of the ceiling at the extremities. Large boulders scattered over the floor came from early rockfalls and these,

e.g. rocks 26 and 27 (Fig. 4), showed bases undermined by water and shingle erosion when the lake level was high enough to wash into the cave. This water action left a beach residue of ignimbrite shingle overlaid by a layer of pumice rubble when the lake level finally retreated.

In the squares near the entrance to the cave (lines of squares 50, 60) the old beach was covered with a soft, sterile, yellow layer of eroded talus material from the rhyolite cliff face above.

The south-west entrance is almost blocked by an external bank held in position by a narrow pillar of rock and rock 19 so that, although the roof is fairly high there, the bank has to be negotiated before reaching the outside. This bank appears to have been formed naturally by rock fall and earth piling up against the outer wall. It may also have been artificially added to as a wind-break, because the opening exposes the cave to the cold, southerly winds. This area was not excavated. The north-east chamber is narrow and low beyond squares 38 and 48. This chamber once had a small opening but it is now filled with earth. The deposits gave no indication that time spent excavating the extremities of these two areas would have been profitable. Figure 4 shows the probable appearance of the cave floor as it would have looked to the first occupants.

The cave roof above the south-eastern entrance was previously several feet forward of the present edge so that originally the recess of the cave beyond the 30/40 baulk boundary line would have been poorly illuminated. Rock 14 would have dominated the central area of the cave, as it stood about 5 feet (ca. 1.5 m) above the floor.

Other water-worn rocks such as 3, 26 and 27, which rested on the cave floor, would have stood about 2½-3 feet (ca. 0.75 - 0.9 m) above the floor during the first occupation. The south-west chamber rocks (19, 18, 8, 7, 6, 5 and 4) were of similar nature but the first occupation did not extend into this area. Later roof falls were scattered over the shingle surface, especially in squares 45 and 47, thus reducing the living floor space considerably. The relationship of rocks 15 and 16 to the floor was not established, as trees prevented full excavation of square 55.

Stratigraphy and Occupation Sequence

Hosking excavated 11 layers, the deepest being layer 11, where the cultural material rested on and amongst the shingle and pumice floor. Figure 5 shows his principal cross-section through the cave. On the basis of the layering and interpretation of rockfalls, the sequence has been divided into three main occupations. Figure 6 shows a schematic representation of these.

Whenever layer numbers are mentioned, these refer to Hosking's excavation. The three occupations described, however, are a reassessment and grouping of the original layers to allow reinterpretation of layers behind the rockfall and their relationships in the light of the Carbon 14 dates.

The stratigraphy was well defined during the earliest occupation but in Occupations 2 and 3 considerably more lensing and redistribution of floor material occurred making interpretation more difficult.

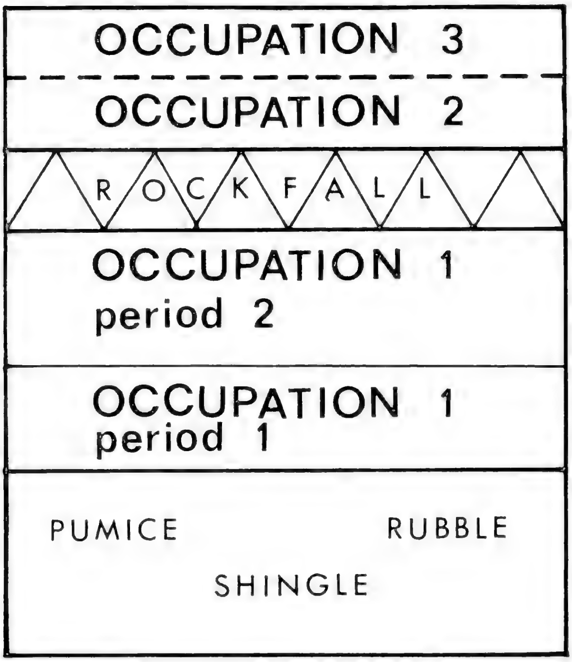


Fig. 6. Schematic representation of cave occupations.

Occupation 1 has been separated into 2 periods. Occupation 1, period 1, represents the initial occupation, Hosking's layers 11 and 10. Cultural material was at first mixed into the soft shingle and pumice surface by trampling and a number of haangi were dug into the rhyolite talus deposits in squares 57 and 56. Occupation continued for a long enough period to allow a hard, black floor to be formed (layer 10) over the beach deposit. The extent of this occupation is shown in Fig. 4.

Occupation 1, period 1, covered a floor space of about 830 ft^2 (c. 77m^2) but only a portion of this was available for use because of the presence of rocks.

Square 46, one of the most significant in the site because of the amount of cultural and midden material it contained, was a working area. Large rocks, especially 26 and 27, would have had tops that were at about waist-height and may have been work-benches, as worked material extended just over the inner side of rock 26, which was in the baulk between squares 46 and 36. This was especially noticeable with the waste obsidian flakes, whose largest concentration was in this area. The obvious place to deposit obsidian waste would have been towards the back of the cave as it would not be advisable to leave the sharp pieces in the living area. However, obsidian flakes were found scattered throughout the other squares as well. This square also contained industrial moa bone and artifacts such as a broken bird spear (Fig. 15), a small pumice adze and a broken bone needle.

Square 56 during Occupation 1, period 1, contained only one large rock and a hard floor was formed on the talus deposit overlying the beach shingle. The position of this square at the cave entrance, the protection it received in the early period from the cave overhang and the fact that it contained little artifactual or

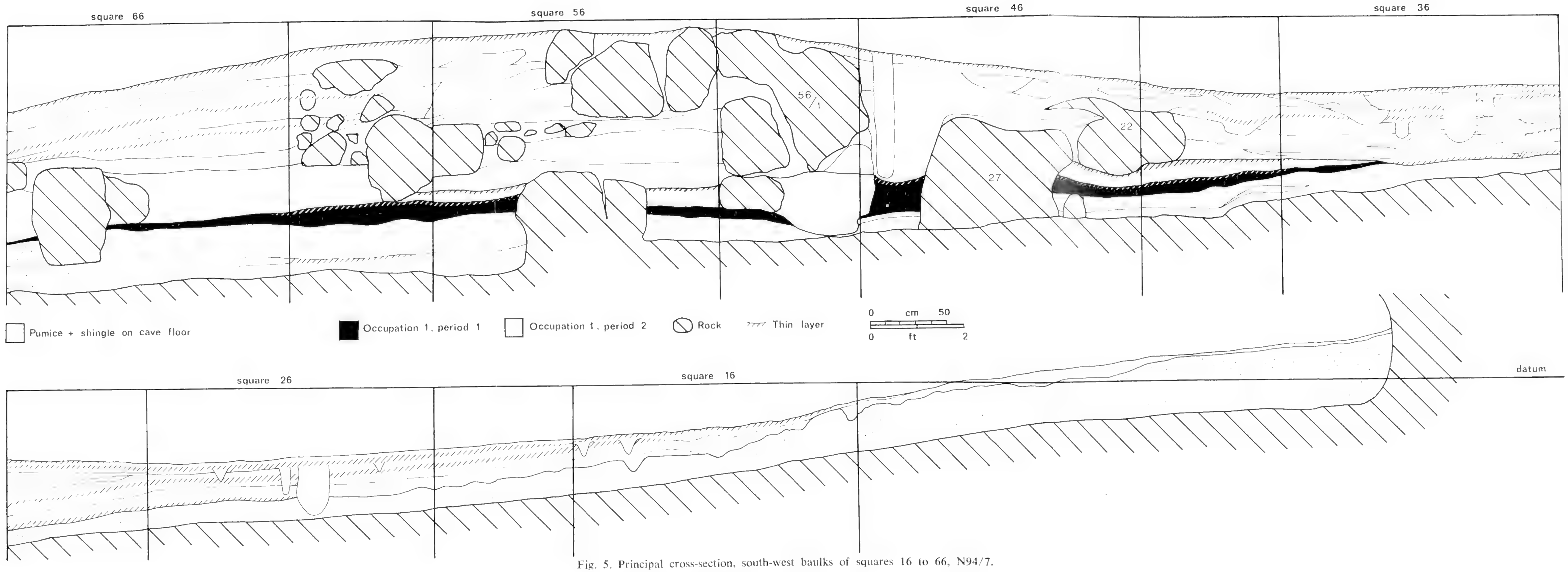


Fig. 5. Principal cross-section, south-west baulks of squares 16 to 66, N94/7.

midden material, suggest that it was a common "vestibule" between the entrance, the working area and the cooking area in squares 57 and 67. A number of haangi, some large, with a number of stones associated with them, while others were just hollow depressions, were situated in this area, near the north-east cave wall. From personal experience, this is the best position for cooking because of the up-draught. Throughout the site description, the term "haangi" is applied to both stone-filled, shallow basins and fire-pit depressions containing charcoal but with no stones closely associated.

Square 45 contained a rock heap but behind this, in square 43, 44 and 47, were rock-free, sheltered portions that could have been used for sleeping. Early occupation material and layers extended into these parts.

Charcoal in a thin, black, cultural layer in square 47 gives a date of 605±56 B.P. (NZ 686A; see below, p.46). An even earlier date (NZ648A) from a haangi from layer 11 was also recorded but is probably not as reliable (see below, p.46).

Occupation 1, period 2, was very similar in pattern to the initial occupation. This represents Hosking's layers 9, 8 and 7 from the cave entrance as far back as the 40/30 boundary baulk line. The cultural material showed little change in type but was less in quantity and varied slightly in distribution. Items such as obsidian flakes and bird bones, although fewer than in period 1, were more abundant in squares 44 and parts of 45 than they had been previously. There is some evidence for either a small roof fall or some rearrangement of rocks on the black floor surface of layer 10, suggesting a time break between the two periods of Occupation 1.

Layer 9 was a soft, black-grey material containing gravel. Layer 8 was similar but rather yellower and with fewer stones. The origin of these layers was unclear but it may have been partly earth and gravel from outside the cave brought in to level off the floor amongst the rocks. Both layers contained cultural material and were more consolidated in some areas than others. Finally a thin, black, hard floor, layer 7, was formed on the surface of these two layers. This also contained cultural material.

The faunal material, including moa bone, was similar to that of period 1 but fewer animals were represented, except for an increase in the number of *Galaxias*. The number of obsidian flakes dropped considerably during period 2, indicating a change in obsidian collecting and working.

Occupation 1, period 2, layers did not extend quite as far over the cave surface as those of period 1. Charcoal from a haangi in square 57, layer 7, gave a result of 479±55 B.P. (NZ 1030A; see below p.46). Statistically, this could represent the same group of activities as NZ 686A, or there could be a minor time break between the two.

At some period after the deposition of layer 7, the overhang at the mouth of the cave collapsed, spilling some material out to the front of the cave and some to the back, covering most of squares 45, 46 and 47 and those nearer the cave entrance. This heap of rocks formed an irregular, rocky sill at the entrance. Further inside the cave, the rocks were prevented from rolling back by the height and

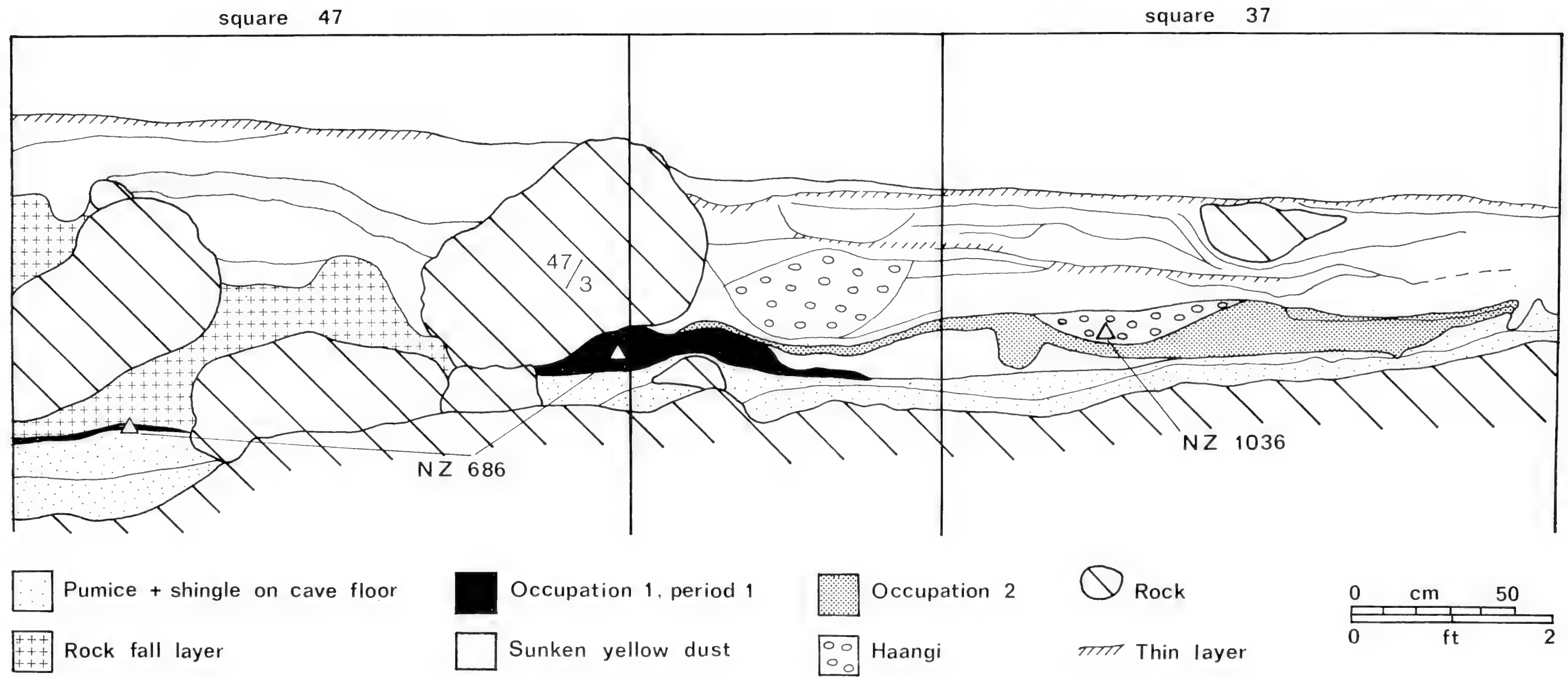


Fig. 7. Cross-section, south-west baulks of squares 47 to 37, showing rock 47/3.

position of rocks 26, 27 and 14. These formed a "dam" at about the position of the 40/30 baulk boundary line. Beyond this line, the back of the cave remained almost as it was originally except for a limited area of occupation 1, period 1, material that extended on to the beach rubble in the front parts of squares 35 and 36.

Tectonic activity or changes in erosion and drainage patterns caused by bush destruction are two possible causes for this collapse.

Some time later, a new series of occupations began. These took place behind the irregular rocky "dam" in the area where the cave floor still remained flattish and much as it had always been. The rocky "dam" area would have become more exposed to the elements but the illumination further back in the cave would have been increased, thus making it more acceptable to live in and more sheltered behind the "dam". Subsequent occupations built up layers but Hosking's layers 9, 8, 7, 6 and 5 in this area cannot represent a continuation of pre-rockfall layers because the latter do not continue beyond the "dam".

After the rockfall, at some later stage, rock 47/3 (Fig. 7) which was standing on end, tilted forward covering the yellow-brown Occupation 1, period 1, material in the baulk boundary line 47/37 and allowing the material behind the rock to sag. It is not clear whether this happened before Occupation 2 or soon after. However, the yellow layer into which a haangi was dug rises up towards rock 47/3 but is not underneath it so, clearly, this layer was deposited after the rockfall. The haangi dug into this yellow layer has a Carbon 14 date (NZ 1036A) of 279±55 B.P.

Nearby, another haangi was dug down into the remnant of the Occupation 1 material in square 36 (Fig. 8). Hosking interpreted this haangi as being from layer 10 and the carbon sample was assigned to layer 10. His note on the carbon sample form reads "Recovered from a hangi cut from the surface of layer 10, and deliberately covered with a layer of yellow grit." This sample was dated to 249±59 B.P. (NZ 1029A). These two results, NZ 1036A and NZ 1029A, appear to date the same occupation. A reassessment of the layers and their relation to the rockfall "dam" showed that the haangi in square 36 had been dug *into* layer 10 and that the layer associated with this haangi rose up against the rockfall and therefore must post-date it (Figs. 8, 9). This reassessment of the stratigraphic position of the haangi fits the Carbon 14 dates, rockfall interpretation and layering more satisfactorily than Hosking's original interpretation and places it in Occupation 2.

Later activities behind the rockfall were not easy to interpret. From the beginning of Occupation 2 onwards, layers containing many lenses were gradually built up. Crumbled, yellow rockfall debris, together with earth, midden, humus and charcoal were continually being added behind the rockfall, first to cover the beach deposit, then to level off haangi scoops, build new ones and cover fires and debris.

A charcoal scatter from a layer further back in the cave than the haangi in the south-east baulk in square 36, but still within the same square, was dated as "modern" (NZ 1031A). A rerun of the sample suggested that it was deposited

Fig. 8. Square 36, south-east baulk, showing edge of haangi (source of Carbon 14 sample, NZ 1029A) dug into layer 10, to left of ranging pole.

Fig. 9. General view of the cave from square 36, north-west baulk, showing rock 26 (centre) and rock 14 (upper left). Note post-rock-fall layers (north-east baulk) rising up to rock-fall.

not earlier than 205 years before 1950 and is more likely to be from the nineteenth century. Hosking assigned this charcoal scatter to layer 9 but, as it is from the layer stratigraphically higher (that is, later) and further back than the haangi in square 36 and as this layer slopes up to the rockfall, it cannot be a continuation of layer 9 in Occupation 1, period 2.

Hosking noted that a series of hard, yellow patches were laid down at about his layer 4 level (Hosking, 1962, p. 29). These patches do not seem to cover all this layer but they could indicate a floor on which later activities or some changes occurred. The earliest European material (an iron hook) was found in layer 4 and it is likely that this "modern" Carbon 14 date can be associated with the new build-up of layers over this patchy floor. These later layers, associated with increasingly prevalent European artifacts, have been assigned to Occupation 3.

Midden material was thrown into the crevices amongst the rockfall and at some period during Occupation 3 this area was deliberately filled in.

Some suggestions of structures were found in the Occupation 2 layers such as a shallow post hole(?) beneath the haangi in square 37 (Fig. 7) but it was not until Occupation 3 that post and stake holes occurred in any numbers. There was no apparent order to them but they can be assumed to indicate racks, wind-breaks and other structures, including those associated with flax working and weaving (on the basis of the botanical evidence).

The number of birds, especially forest birds, decreased in Occupation 2, but the *Hyridella* (fresh water mussel) numbers increased (Table 1). One or two scraps of moa bone occurred but these were residue from isolated pieces deposited on the beach before the rockfall. Greater activity in obsidian flaking and core preparation is suggested by the number of flakes present and the number of pieces showing some cortex. The proportion and composition of imported sea shells also alters (Table 2) when compared with Occupation 1.

Table 1. Minimum number of birds, *Hyridella* and fish (*Galaxias brevipinnis?*) present in the occupation layers, N94/7.

	Birds	*Hyridella*	Fish
Occupation 3	10	120	1
Occupation 2	22	42	11
Occupation 1 period 2	37	4	21
Occupation 1 period 1	54	6	9
	123	172	42

Table 2. Minimum number of sea-shell valves present in N94/7.

	Perna sp. left	*Perna* sp. right	*Amphidesma subtriangulatum*	*Amphidesma australe*
Occupation 3	30	3	6	3
Occupation 2	5	1	83	18
Occupation 1 period 2	present	present	10	6
Occupation 1 period 1	1	1	31	nil

During Occupation 3, little bird bone was found but the number of *Hyridella* increased even more than in Occupation 2. Obsidian working remained important. Especially noticeable is the increase in botanical evidence for flax working and weaving right up until the final occupation layer in the cave.

Of the original rocks in the central chamber, only 3 and 14 and just the tops of a few others, remained above the surface by the end of Occupation 3.

Radiocarbon Dating

Six samples were analysed by the Institute of Nuclear Sciences. The results quoted below are all based on the old half life of Carbon 14, without secular correction, that is they are the dates in the laboratory "A" form.

Sample NZ 648A came from the baulk area between squares 56, 57, 66, 67. The charcoal was selected from a big haangi containing large lumps of charcoal and burnt moa bone. This haangi was the largest in the cave and Hosking considered it to be one of the earliest because of its position in the cave entrance and its relation to the other haangi. It was dug into the rhyolite talus and contained some of the largest ignimbrite haangi stones found in the site. The Carbon 14 date is 1005±57 B.P. (A.D. 945±57). As the charcoal used was from large lumps, and because of the possibility that the early fire had been made from dry, dead timber that could have been in or around the cave at the time of the first occupation, the real age of this haangi is uncertain. Another sample from the same occupation (NZ 686A) from square 47, layer 11, gave a date of 605±56 B.P. (A.D. 1345±56). This charcoal was from a thin, black, cultural layer resting on the pumice rubble and consisted of small, charred twigs. This seems a more reasonable date for the first cave occupation and the sample is more likely to date the actual event because of its composition.

It is possible that the large haangi near the front of the cave could have represented an earlier transitory visit, although the black occupation layer appears to be continuous with the rest of Occupation 1, period 1. A date of A.D. 950. would be within the bounds of possibility given our present knowledge of New Zealand prehistory (Green 1974, p. 29). The Oturehua quarry in inland Otago, for example, is dated to the eleventh century A.D. by two Carbon 14 dates (Leach 1969, p. 72). However, the possibility of the use of relict wood makes the very early date from Whakamoenga questionable and therefore not acceptable until more is known of the archaeology of the inland North Island and the possibility of other early dates occurring there.

Sample NZ 1030A came from an oven in square 57 (layer 7) and was buried by the major rockfall that sealed Occupation 1, periods 1 and 2. It gave a date of 479±55 B.P. (A.D. 1471±55). As NZ 686A and NZ 1030A fall within two standard deviations of each other they could date the same occupation but other evidence suggests that two periods can be recognised before the large rockfall. NZ 1030A was also stratigraphically later than NZ 686A so that these carbon dates appear to be separated by a genuine time interval, even though not of great length. The material culture and the midden material do not indicate a qualitative change but rather a change in amount, quantity and distribution.

Sample NZ 1036A, from square 37, dated 279±55 B.P. (A.D. 1671±55) and NZ 1029A, from square 36, dated 249±59 B.P. (A.D. 1701±59) are considered to be from the second major occupation, which occurred further back in the cave some time after the major rockfall (Figs. 7, 8). These dates are within one standard deviation of each other and probably represent aspects of the same occupation, that is, the first post-rockfall accumulation in the back part of the cave.

Sample NZ 1031A from the north-west baulk in square 36, was from charcoal intermixed with stony, yellow-black material which formed a compact floor. It gave a "modern" date. The sample was rerun by the laboratory and the result (less than 205 years B.P.) supported the original assessment. This sample has already been discussed above (pp.43,45). By the time layer 3 was deposited, muskets were being used, so that a nineteenth century date is quite acceptable for the upper layers.

With the reassessment of the Occupation 2 and 3 layers as being deposited after the rockfall, the Carbon 14 dates which originally seemed anomalous (especially Hosking's layer 9 from square 36) now present a consistent sequence through time and show that Whakamoenga Cave had a long occupation history.

FAUNA

Birds

Dependence on bird hunting in Occupation 1 was evidenced by the number of species present (Table 3). Bush birds were the most common, followed by water birds. Birds from other environments were present but not in significant numbers. Moas were hunted.

The method used to ascertain the minimum numbers was that described by Law (1972, p. 96). This was satisfactory for the Occupation 1 material, where the various species can be assigned to separate layers but during Occupation 2 and 3 the layer distinction is not so clear. A certain amount of cultural material and bone came from deposits probably thrown out amongst the rocks in the front of the cave after the rockfall but before the area was filled in.

Occupation 1, period 1, produced the greatest number of birds, followed by Occupation 1, period 2. Occupation 2 showed a drop in numbers, especially in bush birds, although water birds remain in about the same proportion as Occupation 1. This would suggest that bush birds were harder to obtain, or else less desirable, with the former suggestion more likely. The destruction of the bush in the environs of the cave catchment area probably accounts for their decline.

In Occupation 3, birds become insignificant, except for tui and kaka. Cooper (1851) talks of potted birds, including kaka, at the feast at Pukawa in 1850 (see above, p. 36), and their continued presence in Occupation 3 may be associated with this process. Present in this bone material were wing and head bones, including the ramus of a mandible, suggesting that whole birds had been brought to the cave. However, Downes (1928) recorded that beaks were sometimes tied on to gourd containers to show which species was inside, so the mandible may indicate the presence of potted birds.

Table 3. Minimum number of birds present in site N94/7, by occupation periods and habitat.

Name	Occupation 1 period 1	Occupation 1 period 2	Occupation 2	Occupation 3
BUSH				
Tui *Prosthemadera n. novaeseelandiae*	20	10	3	2
Parakeet (red-crowned) *Cyanoramphus n. novaezelandiae*	12	7	1	—
Parakeet (yellow-crowned) *Cyanoramphus auriceps*	3	4	—	—
Kaka *Nestor meridionalis septentrionalis*	2	3	3	3
Pigeon *Hemiphaga n. novaeseelandiae*	2	3	1	1
Wattled Crow *Callaeas cinerea wilsoni*	1	1	—	—
Kakapo *Strigops habroptilus*	1	—	—	—
Saddleback *Philesturnus carunculatus*	—	1	—	—
Kiwi *Apteryx sp.*	1	—	1	—
N.I. Tomtit(?) *Petroica macrocephala*(?)	—	—	1	—
LAKE/RIVER/SWAMP				
Southern crested Grebe *Podiceps cristatus australis*	1	2	1	—
Duck, small *Anas* sp.	2	1	3	—
Duck *Anas* sp.	1(?)	—	1	—
Grey Duck *Anas superciliosa*	1	—	1	—
Heron-like Bird Family Ardeidae	—	1	—	1
Scaup *Aythya novaeseelandiae*	1	1(?)	1(?)	—
Rail, small *Rallus* sp.	1	—	—	—
Banded Rail *Rallus philippensis*	—	—	1	—
Extinct Coot *Palaeolimnas chathamensis*	1	—	—	—
Shag, small (pied or black) *Phalacrocorax* sp.	—	1	1	—
Shag, large *Phalacrocorax* sp.	1	—	—	—
Dabchick *Podiceps rufopectus*	—	—	—	1
SCRUB/BUSH EDGE				
Weka *Gallirallus australis*	1	1	—	—
Extinct Quail *Coturnix novaezealandiae*	1	1	1	—
SEA/COASTAL				
Gull, black-billed *Larus bulleri*	1	—	1	—
Petrel Petrel sp.	—	—	1	—
Shag, spotted *Stictocarbo p. punctatus*	—	—	—	1
Gannet *Sula bassana serrator*	—	—	—	1
	54	37	22	10

By the time the first Europeans visited Taupo, there were practically no forest stands left in the vicinity of the lake and therefore few bush birds. Waterfowl were mentioned as plentiful, especially ducks. The nearest forests to the cave would be at Mt Tauhara, Opepe, Oruanui and Mokai, all of them, except possibly Mt Tauhara, over a day's journey away.

Tuis were the most common bird in the site but, like other bush birds, their numbers drop off in the later occupations. However kowhai and flax would attract them in the spring even if little forest was present.

Next in importance were the red-crowned parakeet (*Cyanoramphus novaezelandiae*) and yellow-crowned parakeet (*Cyanoramphus auriceps*). These birds are generally associated with podocarp and/or hardwood forest. However, recent work by Taylor (1975, pp. 114-6) suggests that the two species may have distinct habitats. This difference probably had a significance for their hunting during the early period, as it is the red-crowned parakeet that dominates the parakeet numbers. Taylor states (1975, pp. 114-5):

> Little is known of the ecological factor keeping red-crowned, yellow-crowned and orange-fronted parakeets apart on the New Zealand mainland, but marked differences certainly occur. Field observations suggest that the yellow-crowned parakeet is adapted to forest habitats, whereas the red-crowned parakeet is a bird of more open country and forest margins.

Dieffenbach (1843, 1, p. 58) talks of parrots (Kakariki) raiding potato gardens and berries that grew in open and cultivated spots on the ground. The species name he used has since been changed to *Cyanoramphus novaezelandiae* (S. Reed, pers. comm.), that is, the red-crowned parakeet.

Thus the tui and the red-crowned parakeet, which eats mainly vegetation and flowers, would probably be occupying similar territories.

Water birds were fairly evenly distributed throughout Occupation 1 and 2. The nearest suitable habitats would be at the swampy mouth of the Waikato River and across Tapuaeharuru Bay at the Rotongaio lagoon, as the exposed rocky cave foreshore would offer little protection or food for these species.

Although the early travellers talk of the large numbers of ducks, they do not figure substantially in the total bird remains. The presence of the southern crested grebe (*Podiceps cristatus australis*) is interesting as it is no longer found in the North Island. A breeding population must have been present on the lake up to the Occupation 2 period.

Evidence for the extinct coot (*Palaeolimnas chathamensis* Forbes) was found in Occupation 1, period 1. This bird was also present in layer 5 at Hot Water Beach (Leahy 1974, pp. 60, 64) so its presence both on the coast and inland suggests that it was widely spread in early times.

Although the presence of "sea birds" in the cave is not unusual, some of the birds (or bones) must have been carried inland. The black-billed gull (*Larus bulleri*) tends to be an inland resident, especially in the South Island. There are breeding colonies on Lake Rotorua at the present time. Some petrels nest inland and "mutton birds" were collected from certain areas in Taupo in early times

(Hosking, pers. comm.). Two anomalies are the spotted shag (*Stictocarbo punctatus*), represented by a part shaft of a right radius, and the gannet (*Sula bassana serrator*), represented by a left quadrate. Both came from Occupation 3. These two birds are definitely sea-shore animals.

The radius of a shag is a long, thin bone and its presence in the cave might suggest its use for needle or tool-making of some sort. Hamilton (1896, p.174) describes a Maori kete (basket) found near the Upper Taieri in the South Island. It contained a number of items amongst which were "two bones from the wings of an albatross, cut off neatly at each end and prepared for flutes; the holes, however, were not bored." Whether potential flutes or not, these long wing bones performed some function and were part of what seemed to be a "travelling kit" of a Maori woman. Other evidence from its contents is discussed below (pp. 53, 54).

Little can be said of the gannet head bone and its presence and possible use are inexplicable.

The numbers of body bones as well as head, wing and lower leg bones of various birds do not indicate preservation on the site, nor do they suggest that butchering was carried on outside the cave environs. One interesting group of remains came from square 67, Occupation 1, period 1 (layer 10). These consisted of a fragment of sternum, the proximal end of a right ulna, the right tibiotarsus, the right tarso-metatarsus and the proximal end of a right femur of a pigeon. Square 67 was one of the "cooking areas" in the early period. These bones could represent a cooked pigeon split in half and might be one person's portion.

No immature bird bone, except moa, was found in any of the layers. As most birds nest from September to February and many have two or more broods a season, it could suggest that the cave was occupied at a time when most birds had matured. Shortland (1854, p. 198), talking of the upper Wanganui, states:

> About the month of June, a great part of the population migrate to the immense forests lying between their river and the more central parts of the island for the express purpose of catching parrot. Every evening the birds taken during the day are roasted over fires and then potted in calabashes in their grease, for they are very fat. Thus preserved, parrots and other birds are considered a delicacy, and are sent as presents to parts of the country where they were scarce.

This indicates that hunting parties were not deterred by weather conditions inland when some foods were desirable.

Although Taupo winter temperatures and the southerly aspect of the cave would not appear conducive to spending a winter period in the area, the evidence indicates that the birds caught were all mature (except for the moa) and therefore probably captured during the autumn, winter or early spring months.

The cave's dry, sheltered interior, its strategic position in relation to the exploitation of the lake environs, the presence of some important commodity or commodities that required visits to the area and the number of haangi and fire-pits might well indicate winter occupation, especially during the earlier periods.

Commodities such as birds, which feed on podocarp fruits in the autumn and winter; fern root, which was best gathered after burning off in July and August[1]; inanga, which swarmed in the lake between August and September, and crayfish and *Hyridella,* available all the year round, could have supported a group for several months and all these items are ethnographically recorded as having been dried or preserved in the area.

Ample food supplies and adequate shelter could make the cave a very useful camping place during the winter or early spring. Although the Whangamata obsidian would be available throughout the year, this season, because of the food resources, might be a suitable one in which to collect this commodity as well.

Moa

Moa bone was present in the cave during Occupation 1. These birds were used as food and bone for industrial purposes. Charred bones were found associated with haangi. The presence of claws, tracheal rings and pelvis indicated that whole birds were brought to the cave intact, although no head bones were found.

Positively identified are *Euryapteryx curtis* and an immature *Euryapteryx exilis.* Almost positively identified also is *Euryapteryx geranoides* (G. Mason, pers. comm.). Other bones could represent *Euryapteryx geranoides* or *Pachyornis mappini* and *Euryapteryx curtis* or *Anomalopteryx oweni.* At least three species of moa seem to be present in the cave deposits with a minimum of four birds, one of which was immature.

At the base of the rock ledge at the baulk extension of square 43, resting on the pumice rubble, was a heap of egg shell identified as moa (R. Scarlett, pers. comm.). Little is known of moa breeding patterns and the length of time before a bird became fully mature, but it is possible that an egg could be gathered during the nesting period and a young, immature bird from the season before caught at a similar time.

These birds were probably forest-dwelling (Simmons 1968) and, as practically no moa bone was found in the later occupations except for a few scraps apparently dug up from the early layers by haangi activity during Occupation 2, it may be that destruction of the forest affected their ability to survive in the area.

Shellfish

Shells were common and scattered throughout the layers. They were of two types, fresh water and marine. Apart from one small fresh water univalve (*Potamopyrgus antipodarum*) from Occupation 2 which could have been introduced attached to any lake material brought in, all the fresh water shells were the bivalve *Hyridella menziesi,* or kakahi.

These shells were sorted into left and right valves where possible, and the number of right valves used to record the numbers of animals present (Table 1). Layer 10 had only left valves so this group was included. There was also a considerable number of broken pieces of shells in all layers.

---

[1]Colenso (1880, p. 3) and Cassels (1972, p. 24) suggest that fern root was at its most abundant from August until January.

Although the samples are small, it is still possible to suggest some trends in the *Hyridella* distribution. *Hyridella* were not important during Occupation 1 but in Occupation 2 and 3 they increased markedly. Their increase tends to be in inverse relationship to the number of birds present. These shellfish are not considered very palatable these days but they were once a readily available source of protein requiring less effort to obtain than birds and probably fish. Parmalee and Klippel (1974, p. 432) suggest that North American fresh water mussels are not particularly high in food value and contain fewer calories per unit than most other meat animals so that their use would be supplementary rather than staple. However, the ease of collection could balance their lesser food value. This might not apply to the collection of shellfish in Lake Taupo as the beds are usually off-shore and below about 1.8 m of water in most places but dredges could have been used. Collection from rivers and streams would be easier but there are no such places nearer to the cave than the Waikato River or the Rotongaio Lagoon. *Hyridella* will remain alive for at least a week if kept moist, as I have found from personal experience, and these animals could have been so treated during a foraging trip of a few days. The increasing numbers in the later occupations suggest that there was more pressure on animal food resources once the bush had been destroyed.

The *Hyridella* shells, although they have a thick lip along one side, generally do not appear to have been used as scrapers or tools except in a few cases. One shell from Occupation 1, period 1, had a semi-circular groove filed into the lip to form a tool, possibly a scraper for removing bark or some similar activity and one or two shells showed wear-flaking along the lip edge. The thick portion of a *Hyridella* shell from layer 3B at Hot Water Beach had been formed into a fish-hook (Leahy 1974, p. 37) but in general these shells do not seem to have had the qualities necessary for tool-making.

The average length of shells in the cave was between 5 and 6 cm. The smallest was 3.4 cm. Comparisons with modern populations (from the Parau Dam, Auckland and Pukawa, Taupo) show the size of the smallest shell collected was 3.0 cm from Parau and 2.3 cm from Pukawa, so it may be that the cave shells were being selected and very small ones were not being carried to the site.

In contrast to the food potential of the *Hyridella,* a large number of marine shells present appear to have been used as maintenance and/or extractive tools (Binford & Binford 1969, p. 71). The majority of these shells were tuatua (*Amphidesma subtriangulatum*), pipi (*Amphidesma australe*) and the green mussel (*Perna canaliculus*). These shells were brought into the cave as individual items, not as pairs of bivalves associated with food and so have been assessed as single items.

Table 2 shows the distribution of sea shells in the cave.

The *Amphidesma* shells showed heavy wear-flaking round their edges and practically all are broken suggesting their use as scrapers of some sort.

Perna (green mussel) shells seem to have been general purpose tools; as well as their use for fibre scraping they could have served as cutters, bark removers, containers, spoons or scoops for water or earth and other activities. No *Perna* shells were complete. Two showed evidence of use as kokowai containers in Occupation

3. The later increase in *Perna* shells probably corresponds with the increased evidence for flax and fibre working in the same occupation.

From limited study, the type of wear-flaking and edge damage caused by stripping the epidermis from flax with *Perna* shells appears to differ from the type of wear-flaking on the *Amphidesma* shells (unless this results from the physical difference between the shells) but it is still possible that *Amphidesma* shells were also used to strip flax or bark.

Another possible use of *Amphidesma* shells is in scraping fern root. Best (1942, p. 98) makes an interesting comment on fern root preparation:

> There is little to add to the description of the very simple method of cooking the roots [fern root], save that only a few of the accounts recorded mention the scraping process after the roasting or heating at the fire, and prior to the beating or pounding of the root; the scraping removes the black inedible bark-like outer substance of the root, usually with a shell.

Most writers, such as Banks (Beaglehole 1962, 1, p. 416), Cook (Beaglehole 1955, p. 585) and Buck (1952, p. 85) do not mention this shell scraping process. Some scraping activity increased in the cave during Occupation 2, and it could be postulated that this might indicate more dependence on fern root and the scraping with shells during its preparation. The number of *Amphidesma* shells increased tremendously during Occupation 2, at a time when most of the bush had probably been burnt off, but before the land had become infertile, as Bidwill described it, after countless fern and scrub burnings.

Byrne's (1973) analysis of human coprolites from the cave suggests the consumption of fern root during Occupation 2 and 3. Appendix 1 (below) shows the plant identifications and proportions of bracken rhizome remains in the coprolites studied. Coprolites from Occupation 1 show no indication of the presence of this root but some from square 34, layer 7 and those from Hosking's layer 5, both assigned to Occupation 2, give definite evidence for fern root consumption. Occupation 3 material indicated that fern root was still an important part of the diet but Byrne (1973, p. 80) comments on the coarseness of the plant material in the "late" coprolites, due mainly to the large pieces of rhizome fibre. It is interesting to note that the number of *Amphidesma* shells decreased during Occupation 3 and this, together with Byrne's hypothesis that these roots were no longer being as carefully processed before eating, adds to the evidence that one use for these shells may have been in some aspect of fern root preparation.

Table 2 shows an interesting dichotomy between left and right *Perna* valves, with a definite preference shown for the left. Discussions with Maori women and perusal of the literature suggest that, generally, the left valve is preferred for flax scraping because of the handling shape of the shell (see also Mead 1969, Figs. 75a, b).

The contents of Hamilton's Taiere kete (1896, p. 175; and above) included dressed flax, various fibre articles, feathers, a fragment of flax whitebait net and several *Mytilus* shells which had been used for scraping and preparing flax. The *Mytilus* shells have since been identified as *Perna canaliculus* and all three show staining by red ochre pigment, so that their direct association with flax scraping is in doubt (S. Park, pers. comm.). However, Park suggests that once they had

Fig. 10. Left valves of *Perna canaliculus* compacted one inside the other, from square 57, layer 3.

been broken and were no longer useful for scraping, their use might have changed. The shells are all left valves and from the measurements given could well have fitted one inside the other. D.24.581 measures 14.5 cm and 582, 13.5 cm; 585 was too broken to measure but appears smaller. Fig. 10 shows how similar shells from Whakamoenga fit inside one another and could form a compact part of the travelling equipment for a person. They could have been multi-purpose tools or just used for fibre scraping, as is suggested by the botanical remains in Occupation 3. Right valves have similar properties but were not preferred. The number of left valves is almost certainly indicative of fibre working in Occupation 3.

Dentalium nanum shells were also present, three from Occupation 1, period 1, and one from Occupation 1, period 2. Hosking's artifact record book also mentions seven pieces from Occupation 2, squares 45 and 35, layer 5, but no trace of these has been found amongst the material.

One unusual shell was a complete left valve of *Spisula aequilateralis.* It was found in Occupation 1, period 2, (square 57, layer 8). It appeared to have been unused and showed no edge wear or damage. A. W. B. Powell (pers. comm.) states that it is a deep water bivalve and not used by the Maoris for food. It could have been used as a small dish or scoop.

Fish

A number of small fish bones were found in the various layers (Table 1). These have not been fully identified as to species but compare well with the *Galaxias* species found in the lakes and local streams of the area (A. B. Stephenson, pers. comm.).

According to McDowell (1970) the most common of the Galaxiid fish in the Taupo area is *Galaxias brevipinnis.* A specimen that had previously been preserved for internal dissection was obtained. The preserved length was approximately 170 mm but reservations must be made about this length because of its previous treatment. This specimen was dissected for the comparative bone material, as none appeared to be available elsewhere.

McDowell (1970, p. 365) mentions that the greatest length of these fish previously recorded was between 213-240 mm but the average size was between 160-185 mm, indicating that the dissected fish was within the average size range. The netting found in Occupation 3 in the cave had a mesh measurement that would catch fish about this size but let smaller fish escape, although other ways of catching *Galaxias* are recorded in ethnographic literature.

A variety of bones were present in the layers including vertebrae but the head bones were the most easily identifiable. Of those the "fan-shaped" operculum bone was the most common with the pre-operculum and the jaw bones following. It was assumed that these head bones were from *G. brevipinnis,* although most of them were larger than those of the dissected specimen. The size difference may reflect a more suitable environment in prehistoric times, under-exploitation or the use of a net mesh that allowed smaller fish to escape.

Galaxias brevipinnis inhabits a variety of river and lake systems in New Zealand but the Taupo population appears to be largely lacustrine, living in the almost closed system of the Taupo lakes and their tributaries. Elsewhere it may be one of the types that have migratory juveniles (inanga or whitebait) but the Waikato river is the only outlet to the sea and the Huka falls and Aratiatia rapids form a barrier to most fish migration so that most Taupo juveniles swarm within the lake and up its tributaries alone. The inanga hatch by the shores of the lakes and stream mouths during the early spring and, later, some migrate up the various streams.

Grace (1959) devotes a whole chapter to the native fish at Taupo. He says there are no eels in the lake (and no evidence for these was found in the cave) but, in the past, hosts of small fish were seen in great shoals and provided the Maori of those days with an inexhaustible supply of food. Fish in the lake were caught in several different ways, the most common way being by means of a basket net called a pouraka. Grace (1959, p. 510) describes its construction and use (see also Buck 1921 for the various fishing methods in Lake Rotorua). Buck's descriptions probably form the basis for Grace's discussion of fishing methods in Taupo.

Bidwill (1841, p. 54) says that the Maoris told him there were no fish in the lake except those he saw, which were not more than an inch long. They had vast quantities of these dried in baskets which they cooked by making some sort of soup. Possibly the reason that Bidwill saw no larger fish was because the adults tend to spend their lives in small cold, rapidly flowing, rocky streams which are heavily overgrown with bush.

As well as these fish and *Hyridella,* fresh water crayfish (*Paranephrops planifrons*) were plentiful in the lakes and streams. Grace states that these were caught by placing bait inside a mass of fern branches or similar material and leaving it on the lake bottom. Later, it was carefully raised and the entrapped crayfish captured. Crayfish could also be caught by poking a stick into their holes at the sides of streams and, when the stick was seized by the animal, it was carefully withdrawn with the crayfish attached.

Evidence for the presence of crayfish occurred in the cave but the remains were so fragile that they could not be preserved for definite identification. One claw was found in square 48, Occupation 2.

Rat

Rat bones were present in all layers. A sample of these examined by B. F. Leach exhibited a wide size range (Leach, pers. comm.). A few appeared to be outside the range of the kiore or Polynesian rat (*Rattus exulans*) and might well be the European rats, *R. rattus* or *R. norvegicus*. The coefficient of variation is consistently higher for the cave sample than in other collections examined and Leach thinks this probably represents a breeding population.

Leach suggests that "In New Zealand the maxillary tooth row measurement appears to be substantially larger than elsewhere in Polynesia, and there the largest figures are, interestingly, from marginal Polynesia. I mention this because your series from Whakamoenga Cave is the largest recorded that I know of." Leach's work on the Polynesian rat is only tentative because of the small populations he has to work on. As he suggests, the position of the Polynesian rat, and rats in general, is full of confusion, plagiarism and ambiguity.

A few very small bones from the post-European layers could represent mouse bones and there are a few bones of a larger rat, possibly *R. norvegicus* also in the upper layers. One anomaly is from square 67 Occupation 1, period 1, (layer 10) where rat bones beyond the size range of *R. exulans* occurred. Hosking found no evidence of rat burrows in the cave but a rat could penetrate without leaving traces, along the sides of some of the rocks and crevices before the final filling in of the rockfall during Occupation 3. Atkinson discusses the behaviour of the three types of rat present in New Zealand and states that *R. norvegicus* is a burrowing animal (Atkinson 1973). The presence of unidentified Cucurbitacae seeds (pumpkin, squash, melon, cucumber etc.) in the same square but in layers 7 and 9, Occupation 1, period 2, and Cooper's (1851) description of the gardens at Pukawa where pumpkins and melons were growing might suggest that similar plant fruits were taken to the cave and the seeds carried by a burrowing rat into the lower layers. These later European times would fit into Cooper's description and Atkinson's estimation of the possible arrival of the burrowing *R. norvegicus* in the North Island (Atkinson 1973).

There is no evidence for human consumption of kiore in the cave. The bones were well scattered and none was charred. Head bones were as common as body bones. A number of matai seeds were present in all layers and all these had been gnawed at their tops and the kernels removed. The seeds suggest that there were matai trees growing near the cave and that these were exploited by rats rather than by humans. Although this latter possibility cannot be ruled out, there are too few seeds per occupation to suggest that the fruit represented a useful food.

During the excavation, a morepork (*Ninox novaeseelandiae*) visited the cave regularly for cave wetas. A bird of this kind could have accounted for some of the rat bones in the cave as rats form part of their diet. Possibly the tentatively identified North Island tit bones in Occupation 2 may also be the result of a similar meal as it is a rather small bird for human consumption. Other rat bones could have come from the natural deaths of a breeding population through time, although some may have been utilised by humans for food.

Tuatara (Sphenodon punctatus)

At least one tuatara is represented in Occupation 1, period 1. Occupation 1, period 2, contained cranial bones, vertebrae and part of an immature right radius so that at least two of these animals were present in Occupation 1 as a whole. The other bone found, a right radius, was from Occupation 3 (square 67, layer 3). Crook (1975) has recently shown that the tuatara was formerly widely distributed on the main islands of New Zealand. The interpretation of tuatara remains in archaeological sites is still complicated by the possibility of Maori transfer of animals over considerable distances as pets as well as potential food. This was so with the dog and might also be the case with the tuatara.

Dog

Some dog bones were found in Occupation 1, both periods, and the rat-gnawed right ramus of a mandible was found in Occupation 3 (layer 1). Occupation 2 lacks dog bones, although the animal may have been present then and left no trace.

Human remains

Apart from two pieces, all the human bone occurs in Occupation 3. The majority are skull fragments (Appendix 2, below). Of the two earlier pieces, one from Occupation 1, period 1, (square 46, layer 11) appears to be a portion of the extremity of a long bone. It might be part of a bone from a child but its origin cannot be stated with certainty. Its proximal end is charred. The other piece, probably of human origin, has been cut or broken across the top of a long bone and shaped into a chisel-like edge by cutting the bone edges and then polishing the upper and lower sides. P. M. Reeve (pers. comm.) comments that the trabeculae on the under-surface have not been crushed sufficiently to indicate the upper portion being held in the hand or fingers for any length of time, yet the edge appears to show use polish.

The presence of nothing but skull material in the upper deposits of the cave is curious. There are several small caves along the old 110 foot (33 m) lake level in the vicinity that were once used as burial caves but as far as Hosking could ascertain Whakamoenga Cave was never used for this purpose.

Pig

Pig bones occurred in Occupation 3 and this is consistent with ethnographic records. One bone was a scapula that had been worked and modified into a scoop-like object. Although Elder (1962, p.10) makes little comment on the presence of pigs in the Kaimanawa Ranges, which he says are too high for them, Bidwill (1841) mentions their availability in the Taupo and Rotorua region in 1839.

Botanical Evidence

Evidence of plants was present in most layers and included branches, twigs, bark and seeds as well as woven and man-modified plant material. A collection of woven and worked fibres was found in the dusty surface layers of Occupation 3 in a small cleft between rocks 4, 5, 6, 7 and 8 in square 24. This collection included portions of cloaks, netting, prepared flax and other plant material. The majority of botanical remains came from Occupation 3.

Three types of fibre working (mainly flax) occurred in the site. One was the use of strips of unprepared leaf for baskets, mat and net making. Another showed some scraping and removal of the epidermis and finally there was the carefully prepared muka or flax fibre.

Portions of at least two nets (A.R. 5807 and A.R. 5819) were found in this collection. One was fairly worn and had a mesh size of 30 mm, the other appeared less worn and had a mesh size of just under 30 mm (Fig. 11). A third fragile net portion (A.R. 5758) came from Occupation 3 (square 33, layer 3). This had a mesh of 15 mm. This size would probably have been suitable as a white-baiting net, the mesh being about as small as it would have been possible to make from raw flax strips. The larger mesh nets were of a size suitable for catching bigger *Galaxias* but would let small fish escape. The netting knot is the same as that described by Buck (1926, p. 605).

Of the cloaks, none was more than a remnant and they were in a very fragile condition. Three different types were represented. One was Mead's "T" class (Mead 1969, pp. 57, 114), a korowai cloak with rolled fibre tags of the same colour (A.R. 5771). The weft is double pair twining with about 2 cm between wefts. Another was of a similar type but was made from fibre dyed a dull red with red rolled tags (A.R. 5772). A third (A.R. 5772b) was of a coarser weave with wider spaced wefts that were of single pair twining. A considerable amount of leaf epidermis was present and this cloak was probably what Mead (1969, p. 58) describes as M-class, M.1, maimuka with widely spaced wefts.

These artifacts from Occupation 3, square 24, together with a number of flax and other plant material knots, loops, food basket remains, plaited kete edges and other worked pieces rested on a layer of bracken fronds. Other fibrous material included cabbage tree leaves (*Cordyline australis*) and *Astelia* leaves were also present (J. Goulding, pers. comm.).

Three items amongst this collection indicated post-European influence. One was a number of pieces of coarse knitted woollen yarn, possibly heavy sock or woollen stocking (J. Smith, pers. comm), that had a few black hairs about $\frac{3}{4}$ inch (ca.

For cultural reasons, these images have been removed.
Please contact Auckland Museum for more information.

Figs. 11-13. Fibres. 11. Flax netting from Occupation 3 with mesh size of just under 30 mm. 12. Scraped flax epidermis from Occupation 3. 13. Three-ply plaited cordage from Occupation 3.

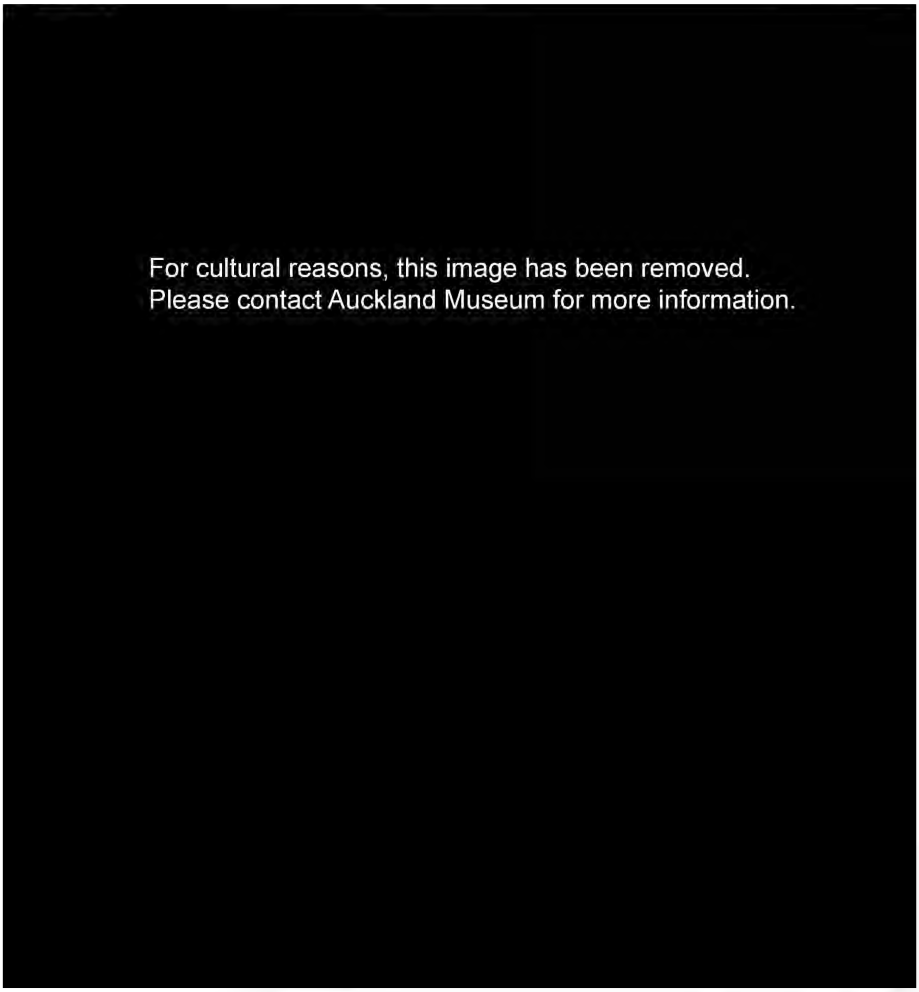


Fig. 14. Gourd lip with stamped and incised decoration, Occupation 3, square 24, layer 1.

19 mm) long attached to them. This could have been horse hair (not positively identified). Another European item was a strip of red cotton material and the third a small piece of twisted sisal fibre (*Agave sisalana*).

Evidence for flax working, especially in Occupation 3 was represented by strips of flax epidermis (Fig. 12). A few pieces of this also occurred in Occupation 2. Flax in both these occupations was also used for binding and cordage. The cordage was mainly 3-ply plaiting (Fig. 13). Occupation 1, period 2, produced no evidence of flax working but a small, very neat and partly burnt piece of flax plaiting was found in Occupation 1, period 1 (square 36, layer 10).

Numbers of pieces of gourd (*Lagenaria* sp.) were present. Some were kokowai covered. In Occupation 3 (square 24, layer 1), a collection of pieces was found that had been carefully lashed to other pieces after the gourd had been broken. This poses the question of what was stored in a gourd receptacle, once broken, although it is possible that the mend could be made water tight. Also from the same square was the neck, or lip portion, of a gourd with a stamped and incised strip of decoration (Fig. 14). This form of decoration on gourds is not known from anywhere else

in New Zealand (D. Simmonds, pers. comm.) but, as it comes from a post-European layer, the design might not be typically Maori. It may, however, represent a style that had long since gone out of fashion elsewhere, such as that found on woodcarving by Cassels (pers. comm.) at Waitore (N136/16), near Patea.

In Occupation 3 (square 67, layer 2) near the mouth of the cave the stem and top of an immature gourd were found, indicating that these "vegetables" were probably being used as food. Colenso (1880,p.15) states that the gourd was a "... prized and wholesome vegetable food (or rather fruit) during the whole of the hot summer days while it lasted and before their kumara were ripe for use ..." Cooper (1851) does not mention gourds growing at Pukawa but they might well have been there, although young gourds could have been brought in from anywhere.

Some small charred pieces of gourd were found in Occupation 1, period 1, so the use of gourds was a feature from the earliest times in the cave.

Bracken (*Pteridium esculentum*) was used in all occupations; probably for bedding and for fire lighting, as many of the stalks were partially burnt. The stalks were also used for artifacts, as one piece in Occupation 3 (square 24, layer 1) was bent into a loop and bound with *Cordyline*.

Evidence for the use of bracken rhizomes as food in Occupations 2 and 3 has been discussed (see above). There is no direct evidence for its use as food during Occupation 1 although it seems likely. Byrne, however, states (1973, p.12) that "the coprolites [that he examined] from the early levels contained very pulpy material, possibly the residue of berries or a root crop such as kumara, those from the later levels contained quantities of bracken fern rhizome." It seems doubtful whether kumara was ever grown in the Taupo area, so that his pulpy material may have been partly due to consumption of softer vegetable material than fern root. However he examined only a sample of the 138 coprolites found and the absence of fern root fibres in Occupation 1 may be due to sampling error.

Karaka seeds (*Corynocarpus laevigatus*) occurred in Occupation 3 and a possible seed case was found in Occupation 1, period 1 (square 46, layer 10). At present there are a few remnant trees standing at Jerusalem Bay but it is doubtful whether these trees are of any great age. They could, however, be a possible source for the Occupation 3 example.

A list of identified plants from the cave is given in Table 4, but there remains a considerable amount of material that cannot be identified. Two pieces of raupo with burnt ends and a twisted circle of native passionfruit vine (*Passiflora tetrandra*) about 6 cm in diameter were found in Occupation 3. Of the leaf material, those of the kamahi (*Weinmannia racemosa*) were present in all layers except layer 11. This tree is still growing in the area today.

Most of the seeds found were rat-gnawed and, as the territorial range of the kiore cannot be great, most of the gnawed seeds including the matai seeds must have come from the cave vicinity. The five-finger seeds (*Pseudopanax arboreum*) from layer 11 also represent kiore food. Leaves from this plant were common in most of the layers.

Table 4. List of botanical specimens identified from Site N94/7.

Name	Occupation 1 period 1	Occupation 1 period 2	Occupation 2	Occupation 3	type
NATIVE SPECIES					
Titoki *Alectryon excelsus*	—	—	—	X	seeds
Astelia *Astelia* sp.	—	—	—	X	leaves
Fern *Blechnum vulcanicum*	—	—	X	—	leaves
Monocot. *Bulbinella* sp.	X	X	X	X	leaves
Sedge *Carex* sp.	—	—	—	X	leaves
Epiphite *Collospermum hastatum*	—	—	—	X	leaves
Cabbage tree *Cordyline australis*	—	—	—	X	leaves
Karaka *Corynocarpus laevigatus*	X(?)	—	—	X	seeds
Cucurbitaceae sp.	—	X	—	—	seeds
Sedge Cyperaceae	—	—	—	X	leaves
Hinau *Elaeocarpus dentatus*	—	—	—	X	seeds
Kiekie *Freycinetia banksii*	—	—	—	X	leaves
Gourd *Lagenaria* sp.	X	—	—	X	fruit
	—	—	X	—	seeds
Manuka *Leptospermum scoparium*	—	—	X	—	seeds
	—	—	X	—	branches
	—	—	X	—	leaves
King fern *Marattia salicina*	—	—	—	X	leaves
Mahoe *Melicytus ramiflorus*	—	—	X	—	leaves
Beech *Nothofagus truncata*	X	—	—	—	leaves
N.Z. passion flower *Passiflora tetrandra*	—	—	—	X	vine
Flax *Phormium tenax*	X	—	X	X	leaves
Fern *Phymatodes diversifolium*	—	—	—	X	leaves
Five-finger *Pseudopanax arboreum*	—	X	—	X	leaves
	X	—	—	—	seeds
Bracken *Pteridium esculentum*	X	X	X	X	leaves
	X	X	X	X	stalks
Matai *Podocarpus spicatus*	X	X	X	X	seeds
Raupo *Typha orientalis*	—	—	—	X	leaves
Kamahi *Weinmannia racemosa*	—	X	X	X	leaves
EUROPEAN INTRODUCTIONS					
Dock *Rumex* sp.	—	—	—	X	leaves
Sisal *Agave sisalana*	—	—	—	X	fibre
Cotton	—	—	—	X	woven
Wool	—	—	—	X	woven

The possibility that Cucurbitaceae seeds from Occupation 1, period 2, (layers 7 and 9, square 67) were deposited there by a burrowing rat has been mentioned above (p. 56). If this is not the explanation, then one would have to postulate that the seeds represent the presence of a botanical species not previously known to have been present in pre-European times. There is some possible comment on this argument. Banks (Beaglehole 1962, 1 p. 417) when talking of gardens seen at Anaura Bay comments:

> In them were planted sweet potatoes, cocos and some one of the cucumber kind, as we judgd from the seed leaves which just appeard above ground; the first of these were planted in small hills, some rangd in rows other in quincunx all laid by a line most regularly, the Cocos were planted on flat land and not yet appeard above ground, the Cucumbers were set in small hollows or dishes much as we do in England.

Banks later was able to state clearly that gourds were grown in New Zealand (Beaglehole 1962, 2 p.9) so that the cucumber plants he saw at Anaura Bay may have been young gourd plants or they may have been something different.

What part the podocarp and dense hardwood forests really played in the economy of the early inhabitants of the Taupo area is hard to ascertain. There probably was extended foraging with the people working the open areas between the forest stands and making full use of the hardwood-scrub forest fringes for bird hunting and for plant foods and materials. Beveridge (1964) has some interesting comments on podocarp fruiting and the associated bird life. However, only a few seeds from podocarps or any forest plants were found in the cave. This may be the result of not using flotation methods, although sieving was carried out.

Although in Occupation 1 the majority of bird bones found represented forest dwelling species, probably many could be caught on the forest fringes as well. The evidence seems to suggest, especially for such birds as the tui and red-crowned parakeet, that it was these fringes that were exploited economically. Once the forest and scrub were destroyed, later peoples had to adapt to an altered environment and evolve new economic approaches in order to survive in the area.

Artifactual Material

Although a considerable amount of artifactual material was found, practically all was incomplete or fragmentary. There were marine shells, woven material, gourds and some bone artifacts. Most of these have been discussed. Other material such as pieces of worked wood, stone and pumice are not included in this paper except in the following short description of a few of the more important items.

Two bone needles were present. A.R. 5739 came from Occupation 2 (square 34, layer 5). It measured 11 cm. The other, A.R. 5936, from Occupation 1, period 1, was about half the size and had the eyelet broken. An attempt had been made to redrill the hole on one side but it was not completed.

A broken bird spear (Fig.15) was also found in Occupation 1, period 1, in a fissure between the rocks in square 46. This indicated at least one of the methods used for catching birds at that time.

For cultural reasons, this image has been removed.
Please contact Auckland Museum for more information.

Fig. 15. Broken bird spear, Occupation 1, period 1, square 46, layer 11.

A small bird-bone toggle, broken in half, came from Occupation 3 and the handle of a stone flax-pounder from the same occupation can be associated with the increased flax-working.

Three very small chips from one or more polished adzes in Occupation 1, period 1, indicated that adzes were used during that occupation.

A considerable amount of worked and carved pumice occurred throughout the deposits. A small pumice adze "model", square in cross-section and measuring about 8.5 cm long was found in Occupation 1, period 1. It may have been a child's toy. Other pumice pieces, varying from round to oval, were hollowed out to form "bowl-like" containers. These were in all stages of manufacture and may have been prepared for removal elsewhere. Their purpose or use is not clear. Other pumice pieces were formed in oval or round shapes in outline but flattened top and bottom. None showed signs of use and, once again, they may have been "blanks" for export. Other pieces had the appearance of having been used as net floats as they had holes drilled through them. One small flattened piece with a central hole came from Occupation 1, period 1.

Two broken pumice patu were found in the later periods. A.R. 5738 came from Occupation 2 (Fig. 16) and A.R. 5787 from Occupation 3 (Fig.17). This patu had been broken in half and later joined together by drilling holes above and below the break and tying the two pieces together with flax. Later the handle broke and it was discarded. These may have been design models, practising weapons or children's toys but they reflect the later proto-historic disturbances in the area.

Obsidian

Approximately 981 pieces of obsidian were present in the site. Occupation 1, period 1, contained 244 pieces, 24.9% of the site total; Occupation 1, period 2, 67 pieces, 6.8%; Occupation 2, 433 pieces, 44.1%; Occupation 3, 237 pieces, 24.2%.

Of the 981 pieces, 179 showed some weathered cortex surface. Of these 179 pieces (over 18% of the cave total), 36 came from Occupation 1, period 1, representing 14.75% of the layer total; Occupation 1, period 2, 6 pieces, 9%; Occupation 2, 78 pieces, 18% and Occupation 3, 59 pieces, 24.9%.

For cultural reasons, this image has been removed.
Please contact Auckland Museum for more information.

Figs. 16, 17. Pumice artifacts. 16. Broken pumice patu, Occupation 2. 17. Broken and repaired pumice patu from Occupation 3.

The source of the water-rolled, boulder-type obsidian is at Whangamata Bay in the Western Bay of Lake Taupo. Pebbles and small boulders can still be picked up on the beach there. It has already been suggested that a canoe would be necessary to collect any amount more than a few small lumps.

Taupo obsidian has been discussed by Green (1962, 1964); Green *et al.* (1967); and Ward (1973).

Obsidian quarries were worked at some stage, further inland along the Whangamata fault (Ward 1973, pp. 93, 100). It is not known whether the cave inhabitants knew of these quarry areas or had access to them, but the amount of cortex pieces suggests Whangamata Bay as the most likely source of the cave obsidian, although other sources may have been worked. Evidence suggests that pebble material was brought to the cave to be worked at leisure rather than being prepared at the collection point.

Both used and unused flakes, including a number of small chips, were present and a few pieces showed secondary flaking. It seems likely that one of the activities of the people in the cave was the preparation of obsidian "cores" to take away. Transport problems would make it necessary to remove any excess weight or bulk first as a considerable amount of walking was required before water transport could

aid travellers (unless only small quantities were being removed at a time). One of the advantages of Mayor Island obsidian must have been the ability to carry large amounts by sea to almost any coastal part of New Zealand. Even if Taupo obsidian had been discovered at a fairly early period, its distribution in bulk, except to selected areas locally, would present logistic problems.

In spite of this, Taupo obsidian had reached Palliser Bay in small amounts by the fourteenth century (Leach 1976, Appendix 17). Evidence from the cave indicated that during the fourteenth and fifteenth centuries, materials, especially obsidian, were being prepared for removal elsewhere. Leach (1976, pp. 174-5) suggests that:

> There was a significant communications link with the resources of the central North Island in the middle of the prehistoric sequence. However this channel apparently dried up some time before the 16th century. Because the contact with the Coromandel-Bay of Plenty continued with only minor reductions at this time, it would appear that material from this area was not coming down through the centre of the North Island on an overland route. A seaward or coastal passage seems more likely.

Occupation 2 at Whakamoenga suggests that trade was still continuing but the outlets are unknown at present. It is possible that it also continued during the early part of Occupation 3 while the first and gradual increase of European influence occurred.

The lack of Mayor Island obsidian in the cave indicates that the earliest sites in the Taupo area have not yet been discovered as it would be expected that early sites would show at least some Mayor Island obsidian, if not the amount shown at Tokoroa (Law 1973).

Preliminary results of hydration rim measurements on obsidian from the cave are discussed in Appendix 3.

Summary and Conclusions

Excavations at Whakamoenga Cave show that the site has been used for habitation discontinuously for 500-600 years or possibly longer.

A cavity in the cliff face was formed at a time when the lake was higher than its present level and, when the water retreated, a shingle and pumice rubble beach remained on the floor of the cave. The cave floor was scattered about with water-worn boulders and later more rocks fell on to the shingle. It was on this shingle and pumice that the first occupation occurred.

The nature of this "beach" shore was such that the earliest deposits were mixed into it. Some haangi were dug, especially in the areas of squares 57, 66, 67, where talus deposits formed a softish layer over the beach layer beneath the entrance. Large ignimbrite stones were gathered either from the shingle floor or, more likely, from beaches nearby to use in the haangi.

There was no evidence for structures during the first occupation and the nature of the shingle base would not have been stable enough to support posts or stakes, although there were a few shallow irregular "stake" holes in the shingle. Some of the rock heaps lying on the floor might have been used as stake

supports for wind-breaks or similar structures but no evidence was found for this. It is not known whether the south-west entrance was open or blocked at this time.

The first main occupation, from its distribution, composition and Carbon 14 dates, seems to have consisted of two periods but with little differentiation between them.

Occupation 1, period 1, has a Carbon 14 date of 605±56 B.P. and lasted long enough for a black charcoal and humus layer to build up on the pumice rubble over the front half of the cave floor. Hosking's layer 11, the first layer in period 1, was rather unevenly distributed owing to the nature of the substrate but this became more consolidated as living debris built up.

This occupation appeared to have a definite distribution of activities, partly imposed on it by the nature of the cave floor and partly from choice within those areas. Certain places took on specific functions, suggested by the presence and nature of the cultural material. These areas may be described as a vestibule at the entrance, a cooking area on one side and a working area amongst rocks 27, 26 and 14. No sleeping area could be recognized but there were sheltered and rock-free, though rather darker, portions further back in the cave that could have been utilized for this purpose.

During Occupation 1, period 1, a large variety of bush birds were caught. No immature birds were present, possibly indicating that birding was not being carried on in the spring and early summer because the group had moved on by then. Some immature moa bones, as well as adult bone, were found in Occupation 1 but little is known of moa breeding patterns and young moa might still be "immature" for a period of up to a year. Water birds were also important. Evidence was found for *Galaxias* sp. and *Hyridella*. *Rattus exulans* bones were present but it is not known whether these animals were eaten or present as breeding populations, or both.

Flax and other fibrous materials were utilized for plaiting and binding, gourds were used for containers and bracken fronds were present. Byrne's (1973) analysis of human coprolites has produced evidence for fern root consumption in Occupations 2 and 3 but indications for this food are lacking in Occupation 1, although it was probably an item in the diet.

Of the materials foreign to the area, sea shells, especially *Amphidesma* species, were used at this period. These shells all showed signs of heavy wear-flaking around their edges, suggesting their use as scrapers of some sort. Practically all were broken. There is no direct evidence to suggest what was being scraped, although fern root is a possibility. No flax fibre was found although flax leaf was being used.

Some, at least, of the obsidian was collected from Whangamata Bay and processed in the cave. The amount of cortex waste suggested that the shaping of obsidian cores and the elimination of unnecessary bulk and weight for carrying elsewhere may have been one of the reasons for the early cave occupation and possibly for the later occupations as well.

Law (1973, p.162) speculates that the Tokoroa site, N75/1, could represent an extended family on a protracted halt in the area. This speculation could well be applied to Whakamoenga Cave, during Occupation 1, when it appears to have acted as a suitable base from which to operate for a period, either for exploration or exploitation of certain resources such as collecting obsidian, or preserving food to take away. The presence of a broken bird spear, a small broken needle, a miniature pumice adze taken together with the estimated floor space available could well fit the idea of a small extended family group utilizing the cave for a period.

Given the Taupo climate, one would expect that groups would be likely to visit the site during the summer. However, the natural food resources and their availability equally suggest that the late winter and early spring were more suitable, especially since crop growth, such as of kumara, would be very marginal. The cave would afford much more warmth and shelter and more protection from the elements than an open air site. There were ample supplies of timber nearby and the cave was in a central position from which to operate, provided a canoe could be used. It seems that the size of the cave, its protection and geographic and strategic position rather than its immediate economic resources were what made it important. Using it as a base, with a canoe, the whole lake environment could be exploited with the minimum of energy expended and this was so from the earliest occupation.

Occupation 1, period 2, with a Carbon 14 date of 479 ± 55 B.P. appeared to be similar to period 1 except that there was a redistribution of some activities in the cave either due to a small rockfall, a rearrangement of rocks or a break in the continuity of the occupation. The midden and cultural material were similar but on a smaller scale. Several Cucurbitaceae seeds from a plant not previously known to have been grown by the Maoris were found but it is possible that these may have been introduced from the higher "European" levels by rats.

During, or more probably after, Occupation 1, the cliff overhang collapsed and a rockfall covered the early occupation. The fall was prevented from rolling further into the cave by the upstanding rocks in squares 45 and 46. These dammed the rockfall, leaving the back of the cave very much as it had been originally. This portion of the cave had not been used during Occupation 1 but loss of the front overhang let more light into this area though the front portion remained piled up with rocks.

By this time most, if not all, of the bush around the lake had been destroyed and replaced by fern and scrub. Sometime later, renewed activities (Occupation 2) occurred behind the rockfall. Evidence included floor material brought in from outside or from around the rockfall, forming a series of lenses and layers over the back of the cave, covering the small Occupation 1, period 1, deposits that extended into squares 35 and 36 and also covering the remaining beach deposits.

A number of haangi and fire-pits were dug into these deposits and samples from two haangi gave similar dates of 279 ± 55 B.P. and 249 ± 59 B.P.

Occupation 2 contained no evidence for moa hunting. About the same number of water birds were present as in Occupation 1 but the number of forest birds decreased considerably. Tui and kaka, however, were still being caught. *Hyridella*

numbers increased, suggesting that they were being used to replace birds as a source of protein. Marine shells, especially *Amphidesma* species, showed a marked increase. These were heavily wear-flaked and most were broken. More *Perna* shells were present, with the dominance of the left valve over the right becoming apparent, suggesting more flax working, and worked flax was found. Gourds were also in use.

Bracken rhizome fibres found in human coprolites from Occupation 2 provide evidence for fern root consumption and this, together with the decrease in forest birds, shows that a different economic pattern had developed due, in some part, to the loss of forest in the area.

Obsidian flakes were the most numerous in this occupation, possibly reflecting exploitation of the inland quarries as well as the Whangamata sources. Increased demand, population pressure or improved communications which allowed a more efficient trading system to develop are possible reasons for this increase.

Broken pieces of a pumice patu from this occupation suggested that power struggles and warfare were affecting people in, or coming to, the area. Pumice bowls and other pumice objects continued to be manufactured and several pieces of a consolidated rhyolitic pumice stone showing "adze sharpening" grooving were found, suggesting that adzes, although not present as artifacts in the cave, were in use.

Although there is no definite break in layers, by Hosking's layer 4 European material began to appear. These uppermost layers have been grouped as Occupation 3.

The number of *Hyridella* shells more than doubled and fern root consumption, which appeared to become important in Occupation 2, continued but with less trouble being taken in its preparation. All bird and fish remains decreased and very few *Amphidesma* shells occurred. There was an increase in the number of *Perna* shells, especially the left valve, which appeared to be the preferred one for flax and fibre scraping, at least in more recent times. The presence of large numbers of these shells is paralleled by the increased amount of prepared fibre and woven material. Obsidian still continued to be important in the early part of Occupation 3, suggesting a continued demand for this material either for use locally or for export.

In the upper layers of Occupation 3, muskets are represented and another broken pumice patu was found. There is historical evidence for increased warfare, pa building, political manipulations and the establishment of several permanent tribes such as the Tuwharetoa in the area. These tribes were able to remain in the area and maintain political influence because of the increasing availability of European economic items such as muskets, potatoes, pigs and trade goods.

Whakamoenga Cave excavations are important to New Zealand prehistory because the occupations cover a considerable time and have produced a large amount of material not normally found in open sites. It is also one of the few

inland sites to be excavated scientifically. This report only studies certain aspects of the material found but nevertheless establishes the foundation on which later work may be based.

Acknowledgements. I would like to thank Trevor Hosking for allowing me full use of his Whakamoenga Cave excavation records and for his assistance throughout the year.

I would also like to thank the following people for reports and comments on various aspects of the excavation and its midden and cultural material: J. Goulding (botanical and fibre identification), A. E. Orchard (botanical identification), D. R. Simmons (woven material), A. B. Stephenson (fish identification), A. W. B. Powell and W. O. Cernohorsky (shell identification), Auckland Institute and Museum; B. F. Leach (rat bone analysis), G. Mason and J. Hamel (bird bone identification), University of Otago; R. Scarlett (bird bone identification), Canterbury Museum; J. Yaldwyn (bird bone identification), National Museum; E. Dawson (bird bone identification), I. A. E. Atkinson (forest regeneration comments), D.S.I.R.; P. M. Reeve (human bone identification), Auckland Medical School; E. Cudby (*Galaxias* and *Hyridella* collections); G. Law (C14 interpretation); R. C. Green, University of Auckland (discussions on stratigraphic interpretation), and R. Cassels, University of Auckland, for overall guidance throughout the writing of this report.

Finally, I would like to express my appreciation to F. M. Cowell for reading and commenting on the manuscript, J. M. Davidson for her constructive editorial comments, and the staff of the Auckland Institute and Museum and the School Service for the encouragement they have given me throughout the preparation of this paper.

APPENDIX I

Analysis of human coprolites from N94/7 (after Byrne 1973, Table 15).

1 g samples		General description	Plant identification	Proportions
Square 24 or 33 21WAK (Layer 1) Sample I	Occupation 3	Very coarse Large no. of components	Bracken rhizome	30%
Square 24 or 33 22WAK (Layer 1) Sample I	Occupation 3	Material coarse Large no. of components	Bracken rhizome	20%
Square 34 23WAK (Layer 5) Sample I	Occupation 2	Coarse to fine Large no. of components	Bracken rhizome Epidermis	10% 20%
Sample II		Fine and pulpy Medium no. of components	Bracken rhizome Epidermis	5% 40%
Square 34 27WAK (Layer 7) Sample I	Occupation 2	Very fine and pulpy Medium no. of components	Bracken leaf frag.	1 only
Square 43 25WAK (Layer 10) Sample I	Occupation 1/1	Fine and pulpy	Epidermis	5%
Square 43 26WAK (Layer 11) Sample I		Coarse to fine Medium no. of components		
Sample II	Occupation 1/1	Very fine Medium no. of components	Epidermis	10%

APPENDIX 2

Report on human bone from N94/7

P. Martin Reeve

Auckland Medical School

There are twelve bones and bone fragments of which ten are definitely human and two probably human. All except the two latter fragments are from the skull. There could be the remains of up to eight individuals or as few as two, with the most likely number being three. Few conclusions can be drawn about the individuals, except that one was probably a female of about 30-40 years, another was of about the same age and a third was somewhat older and suffered an osteolutic lesion of the skull, the latter two of indeterminate sex and race.

AR 5760.

This is a frontal bone, complete except for the right orbital roof and right temporal region. It is rather thick, but of moderate dimensions, and the markings are not pronounced. The lacrimal bones and the frontal processes of the maxillae are attached but not fused, while the horizontal plate of the ethmoid with a prominent crista galli is attached and fused. There appears to be a small area of charring on the right exterior surface of the bone.

AR 5749

This specimen is a portion of the temporal and sphenoid bones which are joined but not fused. The temporal portion is the anterior part of the squamous temporal bone including the root of the zygomatic arch and the mandibular fossa, the spenoidal part is most of the greater wing including part of the orbital wall and the foramen ovale.

AR 5749C

This is a portion of the right parietal bone, being its antero-inferior angle, and there is present the margin that forms part of the pterion, the margin that forms the inferior end of the coronal suture and the margin that forms the anterior part of the parieto-temporal suture, none of which show evidence of fusion. There is a well marked groove for the anterior branch of the middle meningeal artery on its interior surface.

AR 5749D

This is a portion of the right temporal area of the frontal bone, with prominent vascular markings on its interior surface.

The above four bones can be positively fitted and interlocked together, and there is no doubt that they all come from the same individual.

AR 5726

This is a portion of the right side of the squamous part of the occipital bone, on its external surface is a slightly marked superior nuchal line, and on its interior surface is the groove for the right transverse sinus, but the internal occipital protruberance is eroded away.

AR 5799

This is a portion of the left side of the squamous part of the occipital bone, larger in extent than the previous fragment. The external and internal surfaces are similar to the above bone, but there is in addition part of the occipital contribution of the lambdoid suture which shows no sign of fusion.

The two bones cannot be positively fitted together, but there is no overlap and it is likely that they are from the same occipital bone.

AR 5726

This is the right maxilla which has lost most of its superior part. There is a well developed maxillary antrum, but because of the lost bone its roof is missing. The alveolar arch is well developed but no teeth are present. However all the tooth sockets are well developed and there is no evidence of dental disease. The dentition is a fully erupted complete adult set with the presence of an unusual fourth molar. The dental arch is short and the bone is moderate in size.

The above three bones cannot be positively articulated with the first four described, but it is likely from their size, markings and weathering that they are all from the same skull. This is likely to have been female because of its small size, and from an individual aged about 30-40 years because of the development of the maxillary sinus and the state of the sutures.

AR 5641

This is a right temporal bone with an attached part of the greater wing of the sphenoid. The temporal bone is practically complete, except for the tegmen tympani, the zygomatic process and the lateral wall of the mastoid air cells. The sphenoidal part is nearly fused to the temporal bone and may represent an anomalous ossification of the sphenoid. It is difficult to age the bone since the absence of the lateral wall of the mastoid air cells indicates a young individual, say adolescent, but the fusion of the sphenoidal part indicates a rather older individual. Race and sex cannot be reliably determined.

AR 5749A

This is a left temporal bone complete except for the zygomatic process and the lateral wall of the air cells of the mastoid. This bone is better preserved than the one described above, is smaller and of slightly different shape. It could possibly come from the same skull, but there can be no certainty about this. Because of the poor development of the mastoid, it is likely to come from a young individual, say adolescent but again race and sex cannot be reliably determined.

AR 5645

This fragment represents a portion from the left parietal and left part of the squamous portion of the occipital bone, the lambdoid suture between them being nearly obliterated. There is a hole in the parietal portion which appears to be a healing infected lesion of the skull bone. The internal surface presents a faint groove for a branch of the middle meningeal artery and a faint groove for the left transverse sinus. Because of the state of the suture, the state of preservation of the bone and its configuration it cannot belong to the skull of the first described individual and it is most unlikely that it comes from the skull of the two temporal bones described above. It is probably from another individual aged about 50, of indeterminate race and sex.

AR 5520

This appears to be a portion of the extremity of a long bone. It is probably the anterio-lateral portion of the distal end of the left radius, but it could possibly be the popliteal surface of the right femur of a child. It is unlikely to be from the tibia, but its definite origin cannot be stated with complete certainty. Its proximal end is charred.

Uncatalogued

This is consistent with being human but cannot be positively identified as such. It is probably the lower end of an adult femur, because of the curvature of the bone, the thickness of the cortex, the absence of markings and the presence of trabeculae, which are not as well formed in mid shaft. The trabeculae are still intact, not compressed as they might be if the bone had been gripped firmly between thumb and fingers.

APPENDIX 3

Notes on obsidian dating, N94/7

Obsidian hydration rims were measured at the Anthropology Department, University of Auckland in 1962 (Green 1964). Although the results may be obsolete according to today's methods, I feel they are worth quoting (W. Ambrose, pers. comm. to T. Hosking).

> Your earliest levels are possibly between 500 and 800 years old according to the hydration thickness with between 2 and 1.25 microns thick at an estimated rate of about one micron in 400 years. More accurately we could say the age of your earliest specimens is as old as the bottom levels of the Opito Beach midden site. The hydration thickness changes on samples is in conformity with your stratigraphic description which is probably more a check on our readings than on your digging.
> Ambrose adds a postscript "your layer 5 material is possibly less than 200 years old."

This is a very interesting comment when one considers the Carbon 14 results.

The obsidian results from Whakamoenga may be compared with those on Mayor Island obsidian from another inland site at Tokoroa (Law 1973, p. 159). Altogether 26 readings on five surfaces of one flake were done but Law rejects some and states:

> . . . the remaining 19 readings average 1.220±0.021 microns. These are on average thinner, suggesting a more recent age than those from Opito (N40/3), Tairua (N44/2), Sunde Site (N38/24) and the western midden at Harataonga Bay (N30/5) which are all Archaic midden sites. The growth rate of the rim is dependent on temperature, and as all these sites are at sea level and in sand, and as soil temperatures at Tokoroa may be lower, this site may be nearer to equivalent in age to those above.

Ambrose suggests a hydration thickness range between 2 and 1.25 microns for the early levels at Whakamoenga. This appears older than the material from Tokoroa, although details of the number of flakes and readings at Whakamoenga are not available. However, the temperature in the cave must have been constantly higher than the ground temperature at Tokoroa in the winter and therefore hydration rates may have been faster than at Tokoroa. It is possible that Occupation 1 at the cave was closely associated in time with the Tokoroa site.

REFERENCES

ATKINSON, I. A. E.

1973 Spread of the ship rat (*Rattus r. rattus* L.) in New Zealand. J. R. Soc. N.Z. 3 (3):457-472.

BEAGLEHOLE, J. C. (Editor)

1955 *The Journals of Captain James Cook*, Vol. 1. Cambridge University Press for the Hakluyt Society, Cambridge. 684 pp. illus.

1962 *The Endeavour Journal of Joseph Banks, 1768-1771*. The Trustees of the Public Library of New South Wales in association with Angus & Robertson, Sydney. 2 vols. 476, 406 pp. illus.

BEST, Elsdon

1942 *Forest Lore of the Maori*. Polynesian Society, Wellington. (Memoir 19) xi, 503 pp.

BEVERIDGE, A. E.

1964 Dispersal and destruction of seed in central North Island podocarp forests. *Proc. N.Z. Ecol. Soc.* 11 (74):48-55.

BIDWILL, J. C.

1841 *Rambles in New Zealand*. Orr, London. viii, 104 pp.

BINFORD, S. R. and L. R. BINFORD

1969 Stone tools and human behaviour. *Scientific American* 220 (4):70-84.

BUCK, Peter (Te Rangi Hiroa)

1921 Maori food supplies of Lake Rotorua. *Trans N.Z. Inst.* 53:433-451.

1926 The Maori craft of netting. *Trans N.Z. Inst.* 56:597-646.

1952 *The Coming of the Maori*. Whitcombe and Tombs, Wellington. 2nd edition. 551 pp. illus.

BYRNE, D.

1973 Prehistoric coprolites. Unpublished M.A.thesis, University of Auckland.

CASSELS, R. J. S.

1972 Human ecology in the prehistoric Waikato. *J. Polynes. Soc.* 81 (2):196-247.

COLENSO, William

1880 On the vegetable food of the ancient New Zealanders. *Trans. N.Z. Inst.* 13:3-38.

COOPER, G. S.

1851 *Journal of an expedition overland from Auckland to Taranaki . . . 1849-1850.* Williamson and Wilson, Auckland. 310 pp.

CROOK, I. G.

1975 The Tuatara. In G. Kuschel (editor), *Biogeography and Ecology in New Zealand.* Chapter VIII, pp. 331-352. Dr W. Junk, The Hague. 689 pp. illus.

DIEFFENBACH, ERNEST

1843 *Travels in New Zealand; with contributions to the geography, geology, botany, and natural history of that country.* Murray, London. 2 vols. illus. tables.

DOWNES, T. W.

1928 Bird snaring, etc., in the Whanganui River District. *J. Polynes. Soc.* 37:1-29.

ELDER, N. L.

1962 Vegetation of the Kaimanawa Ranges. *Trans. R. Soc. N.Z. Botany* 2(1) : 1-37.

GRACE, John Te H.

1959 *Tuwharetoa; the history of the Maori people of the Taupo district.* Reed, Wellington. 567 pp. illus.

GREEN, R. C.

1962 Obsidian, its application to archaeology. *N.Z. Archaeol. Ass. Newsl.* 5(1) : 8-16.

1964 Sources, ages and exploitation of New Zealand obsidian. An interim report. *N.Z. Archaeol. Ass. Newsl.* 7(3):134-143.

1974 Adaptation and change in Maori culture. Preprint from *Biogeography and ecology in New Zealand.* Dr W. Junk, The Hague. 44 pp. illus.

GREEN, R. C., R. R. BROOKS and R. D. REEVES

1967 Characterisation of New Zealand obsidians by emission spectroscopy. *N.Z.J.Sci.* 10 (3): 675-682.

HAMILTON, A.

1896 Notes from Murihiku. *Trans. N.Z. Inst.* 29:169-178.

HEALY, J., C. G. VUCETICH and W. A. PULLAR

1964 Stratigraphy and chronology of Late Quaternary volcanic ash in Taupo, Rotorua, and Gisborne Districts. *N.Z. Geol. Surv. Bull.* n.s. 73: 1-88, illus.

HOLLOWAY, J. T.

1954 Forests and climate in the South Island of New Zealand. *Trans. R. Soc. N.Z.* 82(2):329-410.

HOSKING, T.

1962 Report on excavation of Whakamoenga Cave, Lake Taupo. *N.Z. Archaeol. Ass. Newsl.* 5(1): 22-30.

LAW, R. G.

1972 Archaeology at Harataonga Bay, Great Barrier Island. *Rec. Auckland Inst. Mus.* 9:81-123.

1973 Tokoroa Moa-hunter site, N75/1. *N.Z. Archaeol. Ass. Newsl.* 16(4):150-164.

LEACH, B. F.

1969 The concept of similarity in prehistoric studies. *Studies in prehistoric anthrolopogy,* vol. 1. Anthropology Department, University of Otago 146 pp., unpaginated appendices, figs. refs. computer print-outs.

1976 Prehistoric Communities in Palliser Bay, New Zealand. Unpublished PhD thesis, University of Otago.

LEAHY, Anne

1974 Excavations at Hot Water Beach (N44/69), Coromandel Peninsula. *Rec. Auckland Inst. Mus.* 11:23-76.

MCDOWALL, R. M.

1970 The galaxiid fishes of New Zealand. *Fisheries Res. Publ.* 133.

MCKELVEY, P. J.

1963 *The synecology of the West Taupo indigenous forest.* Government Printer, Wellington.

MEAD, S. M.

1969 *Traditional Maori clothing.* Reed, Wellington. 238 pp. illus.

NATIONAL RESOURCES SURVEY, Part 2

1962 Bay of Plenty Region. New Zealand Ministry of Works, Town and Country Planning Branch, Government Printer, Wellington.

PARMALEE, P. W. and W. R. KLIPPEL

1974 Fresh water mussels as a pre-historic food. *American Antiquity* 39(3): 421-434.

ROGERS, L. M. (Editor)

1961 *The early journals of Henry Williams, senior missionary in New Zealand of the Church Missionary Society, 1826-40.* Pegasus Press, Christchurch. 524, 4 pp. illus.

SHORTLAND, Edward

1854 *Traditions and superstitions of the New Zealanders: with illustrations of their manners and customs.* Longmans, London. xii, 300 pp.

SIMMONS, D. R.

1968 Man, moa and the forest. *Trans. R. Soc. N.Z. General* 2 (7):115-127.

1969 A New Zealand myth. Kupe, Toi and the "fleet". *N.Z. J. Hist.* 3(1):14-31.

STAFFORD, D. M.

1967 *Te Arawa.* Reed, Wellington.

TAYLOR, N. M.

1959 *Early travellers in New Zealand.* Clarendon Press, Oxford. xxx, [2], 594 pp. maps.

TAYLOR, R. H.

1975 Some ideas on specialization in New Zealand parakeets. *Notornis* 22(2) : 110-121.

WARD, G. K.

1973 Obsidian source localities in the North Island of New Zealand. *N.Z. Archaeol. Ass. Newsl.* 16(3):85-103.

THE TAHANGA BASALT : AN IMPORTANT STONE RESOURCE IN NORTH ISLAND PREHISTORY

P. R. MOORE

N.Z. GEOLOGICAL SURVEY, LOWER HUTT

Abstract. An occurrence of fine-grained basalt at Opito, Coromandel Peninsula was exploited extensively from about A.D. 1300 until (?)Early European times. Adzes, roughouts and flakes of this basalt are common in early sites all along the east coast of the Peninsula, and adzes are widely distributed throughout the North Island. The Tahanga source was the focus of a major industrial centre along the eastern Coromandel coast during the Archaic, and probably Classic Maori Periods.

In 1962, two amateur archaeologists reported the existence of an extensive pre-European quarry site near Opito Bay, Coromandel Peninsula (Fig.1). The site (consisting actually of three main sites, N40/8, N40/261, and N40/262) contains abundant evidence of the quarrying of boulder piles (and perhaps *in situ* rock outcrops) scattered around the roughly dome-shaped hill of Tahanga (Fig. 2). Geologically, this is a volcanic plug of dense, fine-grained basalt constituting part of the Tahanga Basalt Formation (an informal name used to describe the largely intrusive members of the Mercury Basalts).

Only recently, however, has the regional importance of this prehistoric stone source been demonstrated. Preliminary results from a study of the basalt were presented previously (Moore 1975), and the widespread distribution of Tahanga Basalt adzes has subsequently been confirmed by Best (1975).

The present paper is based on examination of collections at the Auckland Institute and Museum, published reports on excavated sites, some of the author's own observations on offshore islands, and various pieces of information gleaned from others. Collections at the Taranaki, Gisborne and National Museums were also briefly examined. The aim of this paper is to provide a broad outline of the distribution of the Tahanga Basalt in time and space, its use, and in particular, to stress its importance in the prehistory of the Auckland Region.

GEOLOGICAL OUTLINE

The geology of Kuaotunu Peninsula has recently been mapped by Skinner (in press), and a simplified geological map of the Mahinapua Bay area, which includes Opito Bay, is shown in Fig. 3. The oldest rocks in the area — plug-domes, lava flows and fragmentals of the Mahinapua Andesite Formation — are commonly deeply weathered and do not provide suitable material for adze manufacture. The younger Mercury Basalts however are less weathered, and the volcanic plugs of fine-grained Tahanga Basalt are a particularly good source of fresh, flake-quality stone. The erosion stages, freshness of the basalt, and its rela-

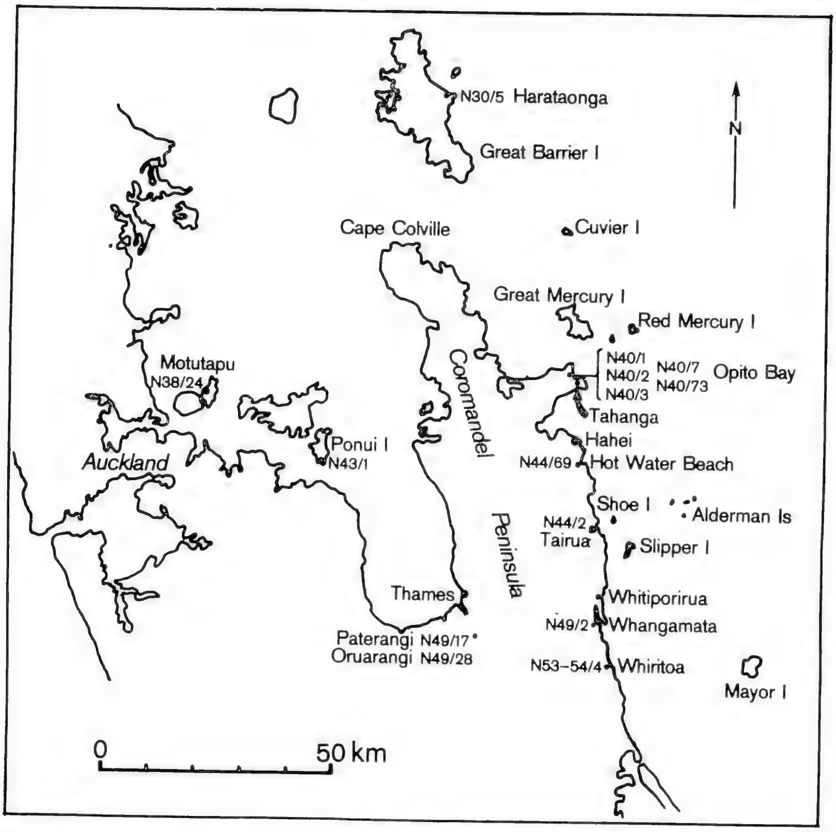


Fig. 1. Map of the Auckland-Coromandel region showing the location of some of the more important sites discussed in the text.

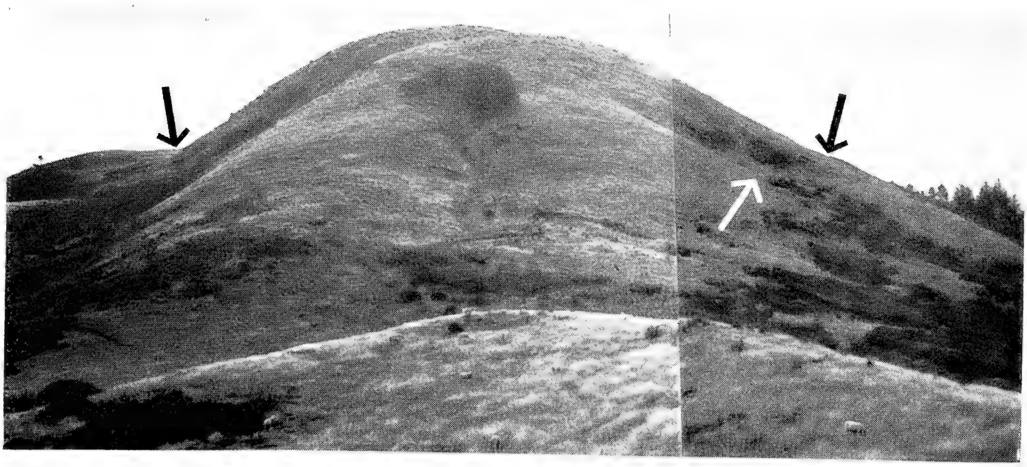


Fig. 2. View of Tahanga (210 m) from the north, showing the position of the three main quarries/working floors. Left, N40/262; upper right, N40/8; lower right, N40/261.

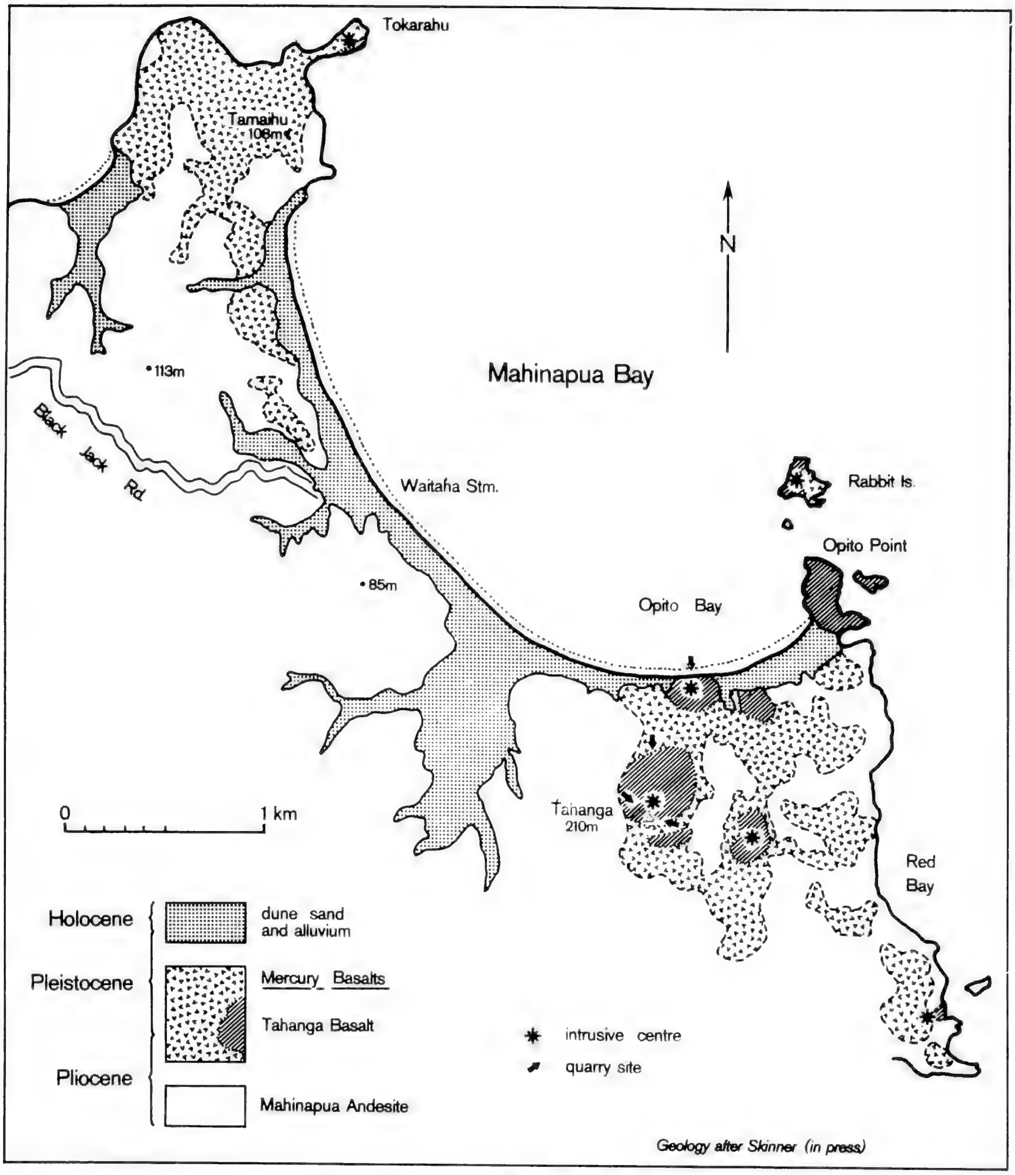


Fig. 3. Simplified geological map of the Mahinapua Bay area, Kuaotunu Peninsula.

tion to terrace levels suggests that the basalt volcanoes, which constitute the last stage of volcanic activity in this area, erupted perhaps 120,000 to 180,000 years B. P. (Skinner, in press).

The Tahanga Basalt is unique amongst the Mercury Basalts of eastern Kuaotunu Peninsula and the Mercury Islands by virtue of its fine grain size, and so far similar rocks are unknown outside Coromandel Peninsula. In addition, outcrops at Opito Bay and Tahanga are the only ones known to have been quarried (or probably quarried), so that flakes, adzes and roughouts of fine-grained basalt can

be assigned to the Tahanga-Opito sources with a considerable degree of confidence.

It is important to note that Tahanga was previously thought to consist of "greywacke" (following Fraser & Adams 1907) and depicted as such on the 1:250,000 geological map of Coromandel Peninsula (Schofield 1967). The error is understandable as the basalt is so fine grained that, in spite of its obvious crystallinity, it could mistakenly be identified as greywacke in hand specimens. However, this error obviously caused some confusion among early excavators in the area (Crosby 1963, p. 17) and undoubtedly resulted in a number of misidentifications of the lithology. This is probably the major contributing factor to delay in recognition of the regional importance of the prehistoric Tahanga Quarry.

TAHANGA QUARRY : DISCOVERY AND RESEARCH

The existence of a pre-European quarry site on Tahanga was first brought to the attention of archaeologists by Messrs. H. Pos and R. W. G. Jolly late in 1962, after a preliminary investigation by Jolly and P. Murdock on July 14, 1962 (Shaw 1963). Trower (1962), during excavations in January that year had already identified one source of basalt cropping out on the shore of Opito Bay. Previously, when excavation began at Sarah's Gully N40/9 in 1956-7 (Golson 1959), the source of recovered stone artifacts was not realised, even though evidence of stone tool manufacture was revealed during excavation.

Between 1957 and 1962 considerable quantities of basalt adzes, roughouts and flakes were recovered from excavations at Opito Beach (Golson 1959; Jolly & Green 1962; Trower 1962), Skippers Ridge (Parker 1959) and Tairua (Smart & Green 1962). Unfortunately material from the latter site was misidentified as greywacke, so that it was not until Crosby (1963) positively identified the source of stone flakes at Whiritoa by petrological examination that the Tahanga quarry was shown to be of more than just local importance.

The importance of the basalt quarry at Tahanga was further stressed when Green (1963, p. 64) stated that this was the source "from which most of the material for archaic adzes on the Coromandel coast comes". The extent of adze manufacture also became apparent from Shaw's (1963) description of the quarries/working floors on and around the hill, where considerable numbers of flakes, flaked cores, roughouts, and hammerstones were recorded. Later site recording by Buist (1965) added two further working floors to this industrial site, and also showed that basalt artifacts were common to all middens in the Kuaotunu area.

More recently Best (1975) has carried out extensive sampling and thin-section examination of the basalt on Tahanga and on the promontory to the north and found little variation in texture. None of the other occurrences of Tahanga Basalt in the vicinity have yet been examined in detail, but they are unlikely to have been quarried to any extent; at least no sites have been recorded on them.

DISTRIBUTION

The widespread distribution of Tahanga Basalt artifacts in the North Island, based largely on the Auckland Museum collections, has already been shown by Moore (1975). Working on collections from Mt Camel, some Manukau Harbour

sites, and Kaupokonui, Best (1975) has since confirmed this distribution pattern by microscopic examination, and his work demonstrates that, except in a few cases, Tahanga Basalt artifacts can be confidently identified by macroscopic methods alone. With the groundwork now completed the distribution pattern of this lithology should be open to considerable modification and expansion.

AUCKLAND

Motutapu Island

Of the five sites excavated on Motutapu to date two, N38/21 and N38/24, are coastal working floors, and at least two other such sites are known (Davidson 1970, p.8). There is therefore considerable evidence for extensive use of local greywacke for adze manufacture, and Motutapu I is likely to have been a major source of stone in the Auckland area.

The discovery of a single roughout adze of Tahanga Basalt (No. 43562) associated with the Sunde site N38/24 (Scott 1970) may have some significance. Although the roughout is a surface find fallen out of the section and hence not able to be related to the stratigraphy of the site, the possibility that it is derived from the cultural layer beneath the Rangitoto Ash cannot be dismissed. (Fig. 4, see below p.86). This level is assigned to the Settlement Phase by Davidson (1972, p.11), but even if the roughout is derived from higher levels (levels 3 and 4) it indicates possible spread of Tahanga Basalt artifacts into the Auckland area during the Archaic Phase of occupation.

Ponui Island

Site N43/1 on Ponui I (Nicholls 1964) is so far the only excavated site in the Auckland area in which *flakes* of Tahanga Basalt have been recognised. The common small flakes and few roughouts from the section indicate that Tahanga Basalt was actually *worked* on the island, even though a good source of greywacke was present only 25 km away on Motutapu I. Unfortunately the stratigraphic position of the flakes is unknown, but the earliest level (level III) at this site has been assigned to the Developmental Phase by Green (1964, p. 138, fig. 2).

The common use of Tahanga Basalt on Ponui I is also supported by the record of basalt "flaked points" (or drill points) from this site (Nicholls 1964, p. 30), and a small collection of basalt adzes from the island as a whole (Auckland Museum collections).

A wide range of flake lithologies including greywacke, basalt and (?)andesite have been collected from site N43/1, in marked contrast to similar sites on nearby Motutapu I. The utilisation of different rock types at this site warrants further study.

Manukau Harbour

Adzes, roughouts and flakes of Tahanga Basalt have been identified by Best (1975 p. 31) in collections from two sites at Wattle Bay — the University site N46-47/16, and the Bramley site N46-47/17. In addition, in a collection of eighteen adzes from near Ihumatao, five were of "early appearance" and all were macroscopically similar to Tahanga Basalt (Best 1975, p. 29). Two of these, and one of the remaining thirteen adzes were thin-sectioned and their Tahanga origin confirmed.

GREAT BARRIER ISLAND

Three sites have so far been excavated on Gt. Barrier, all at Harataonga Bay on the east side of the island (Law 1972). Of these only N30/5 has a rich artifact assemblage and is apparently the oldest, probably Archaic (Law 1972, p. 121).

Numerous flakes of Tahanga Basalt have been collected from this site, and as noted by Law (p. 91) is the most common lithology amongst the flake material. This is significant in view of the fact that a local quarry site has been recorded at Tryphena (Spring-Rice 1962, p. 94); the dominance of Tahanga Basalt may therefore reflect the early age of the site, in good agreement with the dominance of Mayor I obsidian (Fig. 5, see below p. 88).

Basalt is also the dominant lithology of adzes (Law 1972, p.91) and roughouts from the site, and surface collections from Harataonga Bay include a number of adzes and roughouts of Tahanga Basalt (Auckland Museum collections).

COROMANDEL PENINSULA

Of the 14 sites along the east coast of Coromandel Peninsula excavated up until May 1969 (Law 1969) eight provide information on the utilisation of Tahanga Basalt. Five of these are located at Opito Bay within 3 km of Tahanga and hence provide a valuable record of the use of this stone source.

Mahinapua Bay

Of the five main sites considered here, two (N40/1 and N40/3) are middens, N40/2 a flaking floor, and N40/7-73 a pit-terrace complex. Sites N40/1 and N40/2 show a complete dominance of basalt flakes over any other lithology (Fig. 5), whereas N40/3 shows a dominance of siliceous flakes. Although there would appear to be some difference in age between these 3 sites (Green 1964, fig. 2), the different flake assemblage of N40/3 is considered to be related more to function of the site than to age.

Site N40/2 (Jolly & Green 1962) is the only excavated working floor apart from Tahanga Quarry (N40/8) itself. The number of large flakes recovered suggests that roughouts were fashioned here and transported elsewhere for finishing, perhaps to sites like N40/1 where the flakes are generally smaller (Jolly & Green, p. 42). The extent of adze manufacture at N40/2 alone can be gauged from the material recovered from layer 4 in particular — 461 struck flakes, 11 roughouts, 42 broken pieces of roughouts, 4 large core blocks, and two partly ground adzes (Jolly & Green 1962; Jolly & Murdoch 1973).

Basalt flakes recovered from N40/1 range from 4 x 3 cm up to 10 cm diam. in the upper midden (Jolly & Green 1962), though mostly 2-6 cm, and from 4-12 cm in the lower midden. Those from N40/2 range from 3-11 cm, and from one stone pile on Tahanga itself, flakes approx. 13 x 13 cm in size were recovered from a test pit (Shaw 1963, p. 35). There is little doubt therefore of extensive working of large blocks of basalt, which as stated by Jolly & Green (1962, p. 42) "lends credulity to the roughouts for adzes of a foot to a foot and a half in length which have been found elsewhere at this beach".

The stone flake material recovered from excavations at site N40/7 (Parker 1959, 1960) has recently been analysed in detail by Davidson (1975). Basalt flakes and pieces are common in all three occupation layers and there is some suggestion, though somewhat speculative, that utilisation of basalt and other stone materials may have increased with time. The greater proportion of basalt pieces ("flakes" without striking platforms) in the upper levels might indicate increased working of stone, but could equally reflect a change in the type of tool being manufactured or method of production.

Hahei

Site recording in the Hahei area (Moore, n. d.) has revealed several working floors containing abundant basalt flakes, and the possibility of others lying beneath the sand dunes; some sites have already been destroyed. Tahanga Basalt flakes are also common at site N44/90, a midden, and on the headland pa Hereheretaura, site N44/7.

Tahanga Basalt is also the dominant lithology of artifacts in the Harsant Collection (Hahei). Of some 35 adzes and roughouts approximately 25 (or 70%) are of basalt, and these include a wide range of Archaic and Classic types.

Hot Water Beach

Site N44/69, recently excavated by Leahy (1974), is one of the few well-controlled, adequately dated excavations along the Coromandel coast. Even more importantly, its stone flake assemblage has been thoroughly analysed and provides valuable information on the use of various stone materials. In particular, of the 864 pieces of basalt recovered only 97 showed signs of use (Leahy 1974, p. 57), and together with the generally small size of flakes this suggests that pre-shaped blocks of basalt were brought to the site and worked into complete adzes.

Basalt pieces and used flakes occur in all layers; the use of basalt therefore continued over an estimated period of about 250 years at this site, between A.D. 1300 and A.D. 1540 or later (Leahy 1974, p. 73).

Tairua

Site N44/2 (Smart & Green 1962) provides, so far, some of the best evidence for widespread use of Tahanga Basalt in the 13th century, and possibly as far back at A.D. 1100. Basalt tool flakes, recorded as greywacke by Smart & Green (1962, Table 1), are common in Layer 2 which was initially dated at 879±49 yrs B.P. but has subsequently yielded dates of 443 and 570 yrs B.P.

The very high proportion of Mayor I obsidian flakes from this layer and the relatively early date suggested by hydration rim readings (Green 1964, figs. 1, 2) support the 13th century date (or older) for the earliest occupation of this site.

One important aspect arising from the extensive excavation of this site is the clear evidence for differentiation of activities (Jones 1973). The result of differentiation in this particular case is that stone flakes vary in abundance and relative proportion over the site, so that percentages of the various stone materials utilised as represented in Fig. 5 should be treated as approximate only. It follows there-

fore that estimates of age of a site based on relative proportions of flake lithologies must be treated with considerable caution unless supporting evidence, from radiocarbon dates, cultural material, and non-cultural time markers (e.g. Loisels Pumice), is available.

Whiritoa

A single extensive midden at Whiritoa Beach, N53-54/4, has been excavated over a number of years and described by Crosby (1963) and Foreman & Jolly (1965). Tahanga Basalt flakes and adzes occur in the oldest cultural layers which, although not dated precisely, appear to be post Loisels Pumice and possibly belong to the Experimental Phase (Crosby 1963, p. 48).

From the large numbers of roughouts and waste flakes (2,422) of basalt recovered from the site (Crosby n.d.), it is evident that Whiritoa was a working floor. It would appear that large shaped cores were transported from Tahanga Quarry and finished into a wide variety of adzes (Table 1, see below p.90), though it is unknown if all these types were produced during a single occupation or not. The large number of "unused" basalt flakes (96%) might also suggest that this material was readily obtained from its source.

Whitiporirua

Although small excavations of the extensive midden deposits at the south end of the beach (N49/16) have been carried out, the stratigraphy is poorly known. Abundant basalt flakes have been collected, presumably from this site, indicating the presence of working floors.

Whangamata

In contrast to other Archaic middens on the Coromandel coast, the Whangamata Wharf site N49/2 (midden B) contains remarkably few basalt flakes (Allo 1972). Again this is probably related to function of the site, since considerable numbers of dog bones and obsidian flakes were recovered. Only 2 broken adzes of Tahanga Basalt were recorded, one from each midden (Fig. 4).

From a nearby midden however, Shawcross (1964) has recorded a rich assemblage of basalt flakes, including drill points, associated with Classic Maori artifacts (Allo 1972, p. 61). Analysis of these flakes suggests that they are largely the waste products of adze manufacture, but some do show signs of use (Shawcross 1964, p. 18).

Offshore Islands

Surface collections of artifacts have recently been made on Cuvier I (J. Davidson, pers. comm.) but little can be stated at present other than the fact that flakes and roughouts of Tahanga Basalt are found there.

Great Mercury I has been the subject of a recent study by Edson (1973). Tahanga Basalt is represented by abundant flakes, roughouts, and adzes, but little is known of its stratigraphic relationships. Abundant basalt flakes and some roughouts have also been reported from nearby Red Mercury I (Moore 1972 a, b), but again the stratigraphy is unknown.

Further south, sites on the Aldermen Is have, significantly, yielded only a single basalt adze, and no basalt flakes (Moore 1973). The adze, either a 3B or 2C type (Duff 1956), is probably Archaic, correlating well with the almost complete dominance of Mayor I obsidian. However, there is no other evidence for Archaic occupation, and the abundance of Mayor I obsidian may merely reflect the close proximity (37 km) to this source.

Further inshore, some sites on the Slipper Island Group also contain abundant Mayor I obsidian associated with basalt flakes (Atwell *et al.* 1975). Adzes and roughouts of basalt have been collected from Slipper I (Auckland Museum collections), and from nearby Shoe I by the author.

Miscellaneous

Although adzes of Tahanga Basalt have been recorded from a number of localities on Coromandel Peninsula (Moore 1975), in only a few areas do they appear to occur in any number. Thus areas from which ten or more adzes have been collected, such as Amodeo Bay (near Colville), Waihi Beach, and Katikati and Tauranga further south, are likely to provide important information on the use of this basalt source.

Isolated occurrences of Archaic adzes, such as the side-hafted adze collected from Cape Colville (recorded by Duff 1956, p. 196) may also provide an idea of the extent to which this source was utilised during the earliest cultures.

HAURAKI PLAINS

Adzes of Tahanga Basalt have been recorded from a number of localities in the Hauraki Plains, but there seems to be a particular concentration of finds in the Thames area (Moore 1975). At two sites in particular — the swamp pa of Oruarangi N49/28 and Paterangi N49/17 (Shawcross & Terrell 1966) — adzes of this lithology are relatively common, especially at the former site. Of the adzes from "Oruarangi" (including Paterangi?) in Auckland Museum collections approx. 20% are made from Tahanga Basalt, the remainder being mainly greywacke, with a few of andesite and other lithologies. The adzes described by Fisher (1936) from Oruarangi were all considered (p. 18) to be greywacke, but in fact two (Nos 19598.65 and 66) are of Tahanga Basalt. It is interesting to note that these adzes are among the largest recorded (Shawcross & Terrell 1966, fig. 9) and that both belong to Fisher's (1936) type B (later shown to be a variant within a single 2B style by Shawcross & Terrell).

The stratigraphy of these two sites is poorly known and there are no C14 dates available. Doubt has been expressed about the "Classic Maori" style of artifacts from Oruarangi and Paterangi (Shawcross & Terrell 1966, p. 407), and although all the adzes from Paterangi are Duff type 2B, those collected from Oruarangi (Auckland Museum collection) include a number of possible Archaic types in Tahanga Basalt (Best 1975). The high ratio of Mayor I : non-Mayor I obsidian (R. C. Green pers. comm.) in this site also suggests that Oruarangi may have been occupied in earlier times. On the other hand, a ?Classic Maori-European dating of these sites (Shawcross & Terrell 1966, p. 428) could indicate that Tahanga Basalt adzes were still widely distributed in Classic Maori and later times.

OTHER AREAS

Outside Coromandel Peninsula (and northern Bay of Plenty), large numbers of basalt adzes have been collected from only a few areas, namely Rotorua, Auckland City, Muriwai Beach, Maungaturoto, Kaipara Harbour and Mt Camel (Best 1975). Whether this distribution represents a definite trading pattern or simply reflects the more intense occupation of these areas cannot be determined at present, but the widespread occurrence of Type 2B and occasional "hogback" (e.g. Whangaparaoa) basalt adzes suggests at least the Tahanga source was utilised extensively over a long period of time.

STRATIGRAPHY OF SITES

The stratigraphy of some important, well-documented sites in the Auckland - Coromandel Peninsula area, and the types of basalt artifacts recovered from

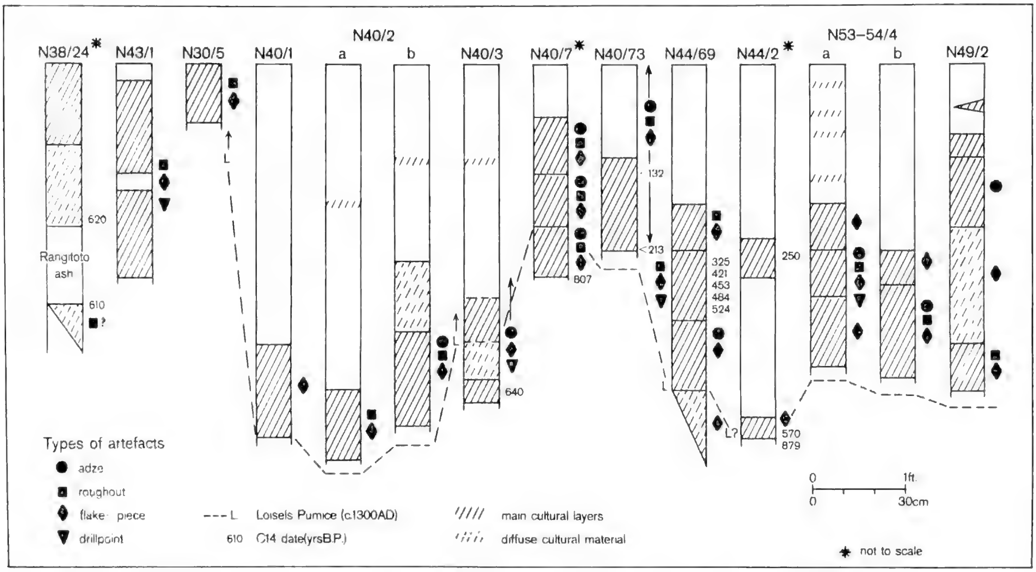


Fig. 4. Stratigraphy of some important sites, and types of basalt artifacts. (Note: for flake-piece read flake + piece)

Key to Figure 4

Site No.	Location	Source of Information
N38/24	Motutapu Is. (Sunde site)	Scott (1970)
N43/1	Ponui Is.	Nicholls (1964)
N30/5	Harataonga, Gt Barrier Is.	Law (1972)
N40/1	Opito	Trower (1962)
N40/2 (a)	Opito	Murdock & Jolly (1967)
N40/2 (b)	Opito	Jolly & Murdock (1973)
N40/3	Opito	Green (1963)
N40/7	Skippers Ridge, Opito	Parker (1959, 1960)
N40/73	Skippers Ridge, Opito	Bellwood (1969)
N44/69	Hot Water Beach	Leahy (1974)
N44/2	Tairua	Smart & Green (1962)
N53-54/4 (a)	Whiritoa	Crosby (1963)
N53-54/4 (b)	Whiritoa	Foreman & Jolly (1965)
N49/2	Whangamata	Allo (1972)

cultural layers within those sites is shown in Fig. 4. The diagram clearly illustrates three main points:

(1) The widespread distribution of Tahanga Basalt in the Auckland - Coromandel region.

(2) The occurrence of basalt artifacts in the *lowest* cultural layers of all of the sites (except perhaps N38/24).

(3) The wide range of artifact types present.

The important stratigraphic records are those of sites N40/3, N40/7 and N44/69, as these provide the most reliable evidence for utilisation of Tahanga Basalt about A.D. 1300. That the basalt was also widely distributed at an early time is shown by the occurrence of artifacts in the oldest layers of two sites well removed from the Tahanga quarry, namely N30/5 (Gt Barrier) and N53-54/4 (Whiritoa).

From the common occurrence of basalt flakes, and in many cases also adzes and roughouts, in the earliest occupation layers it is clear that adze manufacture was one of the main occupations of the early Maori settlers along the east coast of Coromandel Peninsula. The whole of this coast then can be regarded as a major industrial centre, adze roughouts, or perhaps large basalt blocks, being exchanged or obtained directly from the Tahanga quarry and manufactured into finished adzes. Whether or not the manufacturing was carried out by separate groups permanently or seasonally inhabiting the same site, or by a single group migrating up and down the coast is one question yet to be answered.

Relative Chronology of Sites

The distribution of Tahanga Basalt through space, and to some extent time, is illustrated in Fig. 4. Distribution through time is more difficult to assess, and Fig. 5 is an attempt at a relative chronology of some important sites, based on four independent factors:

(1) proportion of Mayor I to non-Mayor I obsidian (Green 1964)

(2) obsidian hydration rim dating (Green 1964)

(3) radiocarbon dates (see Fig. 4)

(4) position of Loisels Pumice (if present) in the stratigraphy of a site (also see Fig. 4).

The figure also shows the relative proportions of *all* stone flakes recovered from the main cultural layer (or layers) of each site. In the case of Oruarangi and Paterangi proportions are based partly on adze lithologies.

The ratio of basalt flakes to flakes of other lithologies (excluding obsidian) may depend largely on the function of the site, and whether or not there is marked differentiation of activities (e.g. Jones 1973). The very different proportions of basalt to "other" flakes in sites N40/3 and N40/7 almost certainly reflects their function, the former being a midden, and N40/7 a pit complex. Thus, it seems unlikely that the proportions of stone flakes alone could ever be used as a *reliable* indicator of age.

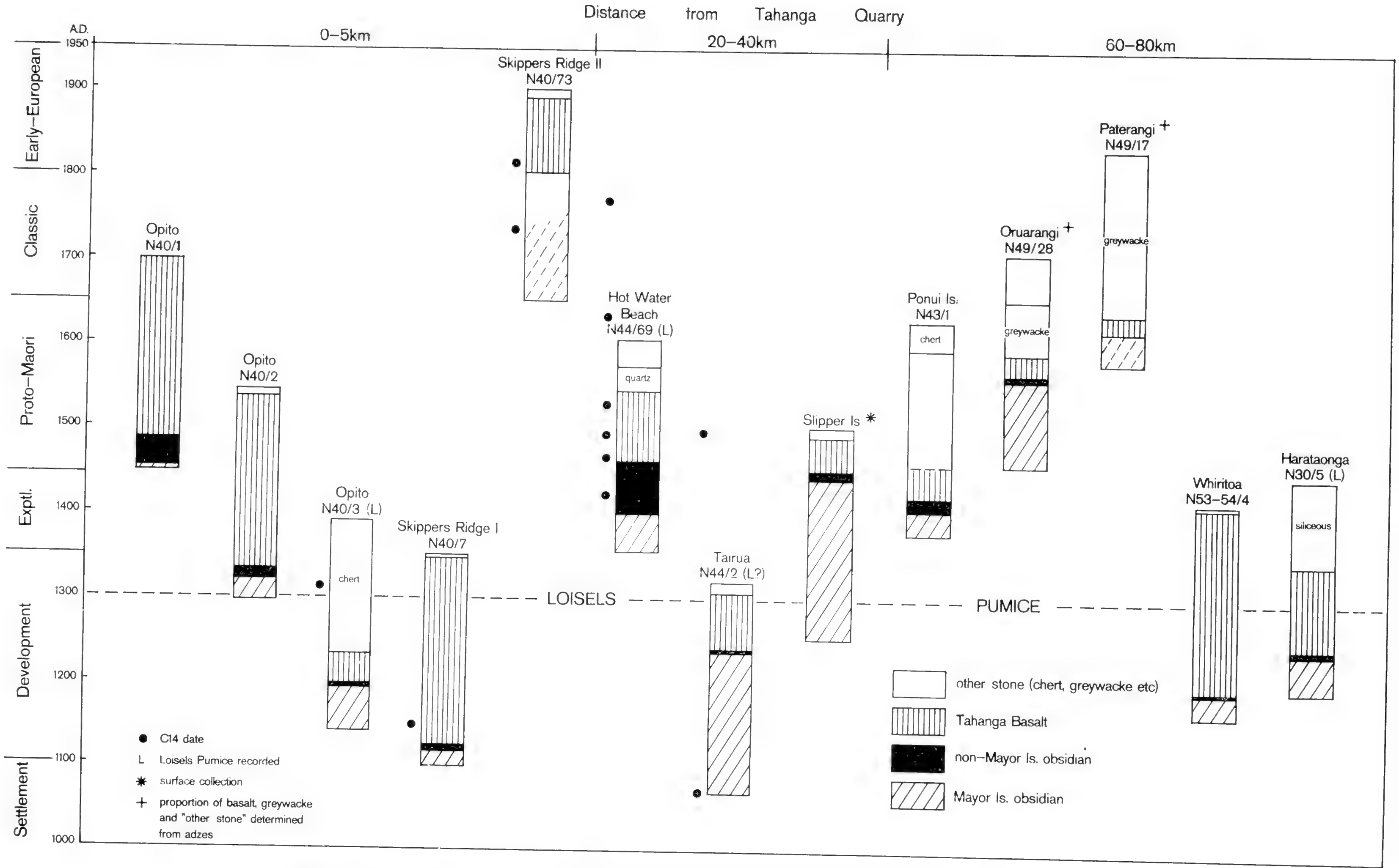


Fig: 5. Relative chronology of sites, and proportions of recovered stone materials.

Since some other evidence for age of sites is available, two rather tentative statements could be made from the data presented in Fig. 5.

(1) That close to its source the basalt seems to have remained an important material until Early European times (site N40/73).

(2) In more distant areas (e.g. Paterangi) use of the basalt may have declined with time, either because of restricted trade or access to the source, or because of a change in technology.

Types of Artifacts and Their Use

The main types of adzes manufactured seem to be the typical Archaic forms — 3B, 4A and 5 — and the main Classic type, 2B (Table 1). Other minor types in basalt are 2A, 3B or 2C, and 3 and less certainly in basalt, types 1, 1A and 6. The widespread occurrence of both Archaic and Classic types also indicates utilisation of Tahanga Basalt over a considerable period of time.

Four side-hafted (Type 5) adzes, probably all in Tahanga Basalt, have now been recorded from Coromandel Peninsula (Table 1). Duff (1956 p. 196) listed only five from the whole of the North Island and, of these, one from Cape Colville is in Tahanga Basalt, a second from Kawhia is in basalt, but of uncertain origin, and a third from Katikati is of unknown rock type. Thus the first use of the Tahanga source can almost certainly be credited to an early (Moa-hunter) culture.

The occurrence of basalt drill points, "knives", flake tools and used flakes points to the use of this material for a wide variety of activities. Few definite uses however have been suggested. Duff (1956 p. 184) has proposed that the side-hafted adze was used for "trimming the inner wall of narrow excavations in wood, such as canoe hulls, food bowls, etc.". A variety of purposely modified flakes and used struck flakes recovered from excavations at Whiritoa (N53-54/4) appear to have been used as hand-held groove tools and simple cutting and scraping tools respectively (Crosby, n.d.). This latter use for flakes is in good agreement with

---

Key to Figure 5

Where sources of information are the same as those given in the Key to Figure 4 they are not repeated.

Site No.	Site Type	Source of Information
N40/1	midden	Jolly & Green (1962); Green (1963, 1964)
N40/2	flaking floor	Jolly & Green (1962); Green (1963, 1964)
N40/3	midden	Trower (1962); Green (1964)
N40/7	pit complex	Green (1964); J. Davidson (pers. comm.)
N40/73	variable activity site	—
N44/69	stratified midden	—
N44/2	variable activity site	—
Slipper Is.	midden	Atwell et al. (1975)
N43/1	midden	—
N49/28	swamp pa	R. C. Green (pers. comm.)
N49/17	swamp pa	Shawcross & Terrell (1966)
N53-54/4	midden	Green (1964); Crosby (n.d.)
N30/5	midden	—

Table 1. Types of basalt artifacts and their abundance.

Site number and reference		Adze types and abundance	Roughout	Flake	Core	Drillpoint
N30/5	(Law 1972)	4A, 1A?	X	C		
N38/24	(Scott 1970)		X			
N40/1	(Green 1963)	(X)		A		
N40/2	(Green 1963; Jolly & Murdock 1973)	3B, 4A, 5	C	A		
N40/3	(Green 1963; Trower 1962)	Archaic (X)		X	X	X
N40/4	(Green 1963)	Archaic (X)				
N40/7	(Parker 1959; Green 1963; Davidson, pers. comm.)	2B?, 3, 4A	C	A	X	
N40/8	(Shaw 1963)		A	A	C	
N40/9	(Green 1963)	4A				
N40/10	(Green 1963)	(X)		X		
N40/73	(Bellwood 1969)	2B, 2A	X	C	X	
N40/75	(Moore 1972a)	2B	X	A		
N43/1	(Nicholls 1964)		X	C		X
N44/2	(Smart & Green 1962)			C		
N44/69	(Leahy 1974)	3B, 4B, 5	X	A	X	X
N44/90	(Moore, n.d.)			A		
N45/5	(Moore 1973)	3B or 2C				
N49/2	(Allo 1972)	(R)		R		
N49/–	(Shawcross 1964)		X	A		X
N49/17	(Shawcross & Terrell 1966)	2B (C)				
N53–54/4	(Green 1959; Crosby 1963, n.d.; Foreman & Jolly 1965)	3B, 4A, 5 1, 6?, 2B?	C	A		X
Cape Colville	(Duff 1956)	5				

(A = abundant; C = common; R = rare; X = present, abundance unknown)

that suggested by Bellwood (1969, p. 210), namely in polishing or finishing of woodwork, and possibly for flax preparation. The poorer cutting ability of basalt edges (as compared with obsidian) but greater resistance to chipping and abrasion would tend to suggest this was a major use for flakes.

Possible knives have been recorded by some authors (Parker 1959; Leahy 1974) but their purpose is unknown.

Discussion and Conclusions

The importance of Tahanga Basalt in the prehistory of the northern half of the North Island in particular has now been amply demonstrated. Recent work by Best (1975) has confirmed the widespread distribution of this rock type, its distinctive and uniform character, and restricted occurrence. Published excavation reports provide evidence of its early and long-continued use, particularly in the Coromandel region, and evidence that the eastern Coromandel coast was a major adze manufacturing centre. The main conclusions that can be made are:

(1) The Tahanga source was probably discovered about A.D. 1200, or perhaps even earlier; certainly the basalt was widely distributed by A.D. 1300.

(2) Use of the basalt continued over a long period of time, and near its source, probably until Early European times.

(3) Along the eastern Coromandel coast at least, large pre-formed blocks of basalt were probably traded and/or obtained directly from the source.

(4) The stone was used in the manufacture of a wide variety of adzes, but particularly Archaic types. Waste flakes were probably used in woodwork, or for the preparation of flax.

Still some important questions have yet to be answered. For instance, what is the relationship of the Tahanga Quarry to nearby quarries at Motutapu I and Tryphena, and the gabbro source in Northland (Best 1975)? What are the details of its distribution and chronology in the southern North Island? Why do large numbers of Archaic Tahanga Basalt adzes occur at Mt Camel, as has been shown by Best (1975), and do similar records of early trade or direct exploitation exist in other areas far removed from the source? And finally, what was the nature of the adze-manufacturing population along the eastern Coromandel coast?

Some of these answers might be found in existing records, but obviously there is ample scope for further original investigation.

Acknowledgements. This paper owes much to the generous and willing assistance given by Miss J. Davidson and Professor R. C. Green. I also wish to thank Dr D. N. B. Skinner for geological information, Mrs F. Harsant for permission to examine the Harsant Collection, Miss E. Crosby for use of an unpublished manuscript, and Miss M. Phelan for typing. Mr I. Keyes kindly commented on the text.

REFERENCES

ALLO, J.

1972 The Whangamata wharf site (N49/2): excavations on a Coromandel coastal midden. *Rec. Auckland Inst. Mus.* 9: 61-79.

ATWELL, E. G., J. R. H. SPENCER, G. F. PUCH, and P. R. MOORE

1975 Archaeological site survey of Shoe Island and the Slipper Island Group. *Tane* 21: 71-90.

BELLWOOD, P.

1969 Excavations at Skipper's Ridge, Opito Bay, Coromandel Peninsula, North Island of New Zealand. *Archaeol. and Physical Anthropol. in Oceania* 4(3): 198-221.

BEST, S.

1975 Adzes, rocks and men. Unpublished M.A. research essay, University of Auckland.

BUIST, A. G.

1965 Site recording, Kuaotunu Point, Coromandel Peninsula. *N.Z. Archaeol. Ass. Newsl.* 8(4): 130-147.

CROSBY, E.

1963 Preliminary report on Whiritoa. *N.Z. Archaeol. Ass. Newsl.* 6(1): 46-48.

n.d. Whiritoa. Unpublished MS.

DAVIDSON, J.

1970 Survey of archaeological sites on Motutapu Island. *Rec. Auckland Inst. Mus.* 7: 1-12.

1972 Archaeological investigations on Motutapu Island, New Zealand. *Rec. Auckland Inst. Mus.* 9: 1-14.

1975 The excavation of Skipper's Ridge (N40/7), Opito, Coromandel Peninsula, in 1959 and 1960. *Rec. Auckland Inst. Mus.* 12: 1-42.

DUFF, R.

1956 *The Moa-hunter Period of Maori Culture.* 2nd Ed. Govt. Printer, Wellington.

EDSON, S. C.

1973 Human ecology and prehistoric settlement on some offshore islands (East Cape to Cape Reinga), New Zealand. Unpublished M.A. thesis, University of Auckland.

FISHER, V. F.

1936 The material culture of Oruarangi, Matatoki, Thames. III. Stone implements and ornaments. *Rec. Auckland Inst. Mus.* 2: 15-27.

FOREMAN, J. M., and R. G. W. JOLLY

1965 Report on Whiritoa Beach site, Coromandel Peninsula. *N.Z. Archaeol. Ass. Newsl.* 8(4): 149-151.

FRASER, C., and J. H. ADAMS

1907 The geology of the Coromandel Subdivision, Hauraki, Auckland. *N.Z. Geol. Surv. Bull.* No. 4(N.S.) : 1-154.

GOLSON, J.

1959 Excavations on the Coromandel Peninsula *N.Z. Archaeol. Ass. Newsl.* 2(2): 13-18.

GREEN, R. C.

1959 A survey of sites along the Coromandel coast. *N.Z. Archaeol. Ass. Newl.* 2(2): 20-25.

1963 Summaries of sites at Opito, Sarah's Gully, and Great Mercury Island. *N.Z. Archaeol. Ass. Newl.* 6(1): 57-69.

1964 Sources, ages and exploitation of New Zealand obsidian. *N.Z. Archaeol. Ass. Newsl.* 7(3): 134-143.

JOLLY, R. G. W., and R. C. GREEN

1962 Beach middens on the Coromandel coast. *N.Z. Archaeol. Ass. Newsl.* 5(1): 41-43.

JOLLY, R. G. W., and P. MURDOCK

1973 Further excavations at N40/2, Opito Bay. *N.Z. Archaeol. Ass. Newsl.* 16(2): 66-72.

JONES, K.

1973 Excavations at Tairua (N44/2) 1958-64: A synthesis. *N.Z. Archaeol. Ass. Newsl.* 16(4): 143-150.

LAW, G.

1969 Review of sites excavated in the northern North Island, New Zealand. *N.Z. Archaeol. Ass. Newsl.* 12(3): 164-177.

1972 Archaeology at Harataonga Bay, Great Barrier Island. *Rec. Auckland Inst. Mus.* 9: 81-123.

LEAHY, A.

1974 Excavations at Hot Water Beach (N44/69), Coromandel Peninsula. *Rec. Auckland Inst. Mus.* 11: 23-76.

MOORE, P. R.

1972a Maori artefacts from Red Mercury Island. *Tane* 18: 119-121.

1972b New sites on Red Mercury Island. *N.Z. Archaeol. Ass. Newsl.* 15(2): 54-56.

1973 Evidence of former Maori occupation of the Aldermen Islands. *Tane* 19: 21-29.

1975 Preliminary investigation of the Tahanga Basalt, Coromandel Peninsula. *N.Z. Archaeol. Ass. Newsl.* 18(1): 32-36.

n.d. Notes on the Hahei Islands and adjacent mainland, Hahei, Coromandel Peninsula. *Tane* 22 (in press).

MURDOCK, C. J. and R. G. W. JOLLY

1967 An excavation at Opito Bay. *N.Z. Archaeol. Ass. Newsl.* 10(4): 157-166.

NICHOLLS, M. P.

1964 Excavations on Ponui Island. *Rec. Auckland Inst. Mus.* 6(1): 23-37.

PARKER, R. H.

1959 A new site at Opito. *N.Z. Archaeol. Ass. Newsl.* 2(2): 18-20.

1960 Reconnaissance at Skipper's Ridge. *N.Z. Archaeol. Ass. Newsl.* 3(2): 39-41.

SCHOFIELD, J. C.

1967 Sheet 3 Auckland (1st Ed.) "Geological map of New Zealand 1:250,000". D.S.I.R., Wellington, N.Z.

SCOTT, S. D.

1970 Excavations at the "Sunde site" N38/24, Motutapu Island, New Zealand. *Rec. Auckland. Inst. Mus.* 7: 13-30.

SHAW E.

1963 Maori quarry, Tahanga Hill, Opito. *N.Z. Archaeol. Ass. Newsl.* 6(1) : 34-36.

SHAWCROSS, F. W.

1964 Stone flake industries in New Zealand *J.Polynes. Soc.* 73(1): 7-25.

SHAWCROSS, F. W. and J. E. TERRELL

1966 Paterangi and Oruarangi swamp pas. *J. Polynes. Soc.* 75(4): 404-429.

SKINNER, D. N. B.

n.d. Part sheets N35, N36 and N39, and sheet N40 "Geological map of New Zealand 1:63,360" D.S.I.R., Wellington, N.Z. (in press).

SMART, C. D. and R. C. GREEN

1962 A stratified dune site at Tairua, Coromandel. *Dominion Mus. Rec. Ethnol.* 1(7) 243-266.

SPRING-RICE, W.

1962 Great Barrier Island. *N.Z. Archaeol. Ass. Newsl.* 5(1): 92-95.

TROWER, D.

1962 Opito Beach: two sites. *N.Z. Archaeol. Ass. Newsl.* 5(1): 43-46.

NEW AND INTERESTING RECORDS OF ADVENTIVE PLANTS FROM THE AUCKLAND INSTITUTE AND MUSEUM HERBARIUM 2

E. B. BANGERTER

AUCKLAND INSTITUTE AND MUSEUM

Abstract. This second list of recent additions to the Auckland Institute and Museum Herbarium (AK) and of some re-identified earlier gatherings provides further information on the distribution of adventive species.

Since my first account (Bangerter 1975) of some adventive plants, either recently acquired or re-identified, further specimens have been added to the Auckland Institute and Museum Herbarium and corrections have been made to other earlier gatherings. The new material has been collected mainly by the Herbarium staff or myself, in sufficient quantity where possible, to provide specimens for overseas exchange. As a follow-up to the distribution, noted in my previous list, of a segregate species, *Aphanes microcarpa*, a further locality is given: in earlier publications this would have been placed in the aggregate *Aphanes arvensis*. Further localities are also given for *Vicia disperma* to indicate its wider occurrence, not only in the Auckland Domain, but well beyond.

To aid in the identification of closely allied species such as *Cardamine hirsuta* and *C. flexuosa* attention is drawn to literature where more detailed information may be found. Reference to early published lists has enabled a more complete historical background to be provided for herbarium specimens such as that of *Barbarea vulgaris*, formerly misplaced under *Brassica* sp.

The nomenclature adopted is that published by the New Zealand Weed and Pest Control Society (1969). For species not included in that work references are given to the publications consulted. Specimens are cited by collector's numbers or, in the absence of these, by the AK Herbarium number.

CRUCIFERAE

Barbarea intermedia Bor.

Three gatherings of this species are in the Herbarium, two from the same locality: Lake Waikaremoana, camping ground, 1958, P. Hynes, AK 50337; Lake Waikaremoana, 1974, E. B. Bangerter 5212; and one from Waitomo, Awakino Gorge, 1975, J. H. Goulding 622. I have found few records in the literature for this species: Healy (1969) for Canterbury and Wardle (1975) for Westland National Park. Allan (1940) gives "occasional in waste places in both Islands" but comments " . . . the records of the different species of *Barbarea* are untrustworthy and the distribution of all needs further investigation."

Barbarea vulgaris R. Br.

Canterbury, Ashburton, undated, W. W. Smith, AK 63227, 63229 as *Brassica* sp. These two sheets have Herb. T. F. Cheeseman labels which bear no date, but Smith (1904) includes the species in his Ashburton list, which is referred to by Healy (1969). This record may thus be taken as a trustworthy one.

Cardamine flexuosa With.

Waitakere Range, damp shady hollow, 1973, A. E. Orchard 4035; Torbay, Awaruka Bush Reserve, by creek, 1973, E. B. Bangerter 5094; Mairangi Bay, weed in damp area of neglected garden, 1975, E. B. Bangerter 5256. These are the only gatherings in the Herbarium of this species, the distributional history of which in New Zealand is given by Healy (1957). Detailed description of this and the allied adventive of drier situations, *C. hirsuta* L., are provided by Pritchard (1957) where he discusses their relationship to native species.

Raphanus maritimus Sm.

Lower Hutt, Avalon, Hutt River riverbank, 1975, J. H. Goulding 662. I cannot trace early records of this species but Healy (1957) cites specimens from the Silverstream/Upper Hutt district and from Eastbourne, Wellington Harbour. Miss Goulding's material is in good fruit, showing the fewer, deeply-constricted joints and relatively shorter beak. It is the only certain representative of this species in the Herbarium, most gatherings being referable to *R. raphanistrum* L. or being inadequate for certain identification.

CARYOPHYLLACEAE

Lychnis flos-cuculi L.

Raglan, Onewhero farm, 1975, D. Walter, AK 137351. This is the only New Zealand specimen in the Herbarium of this species, which is recorded by early botanists e.g. Cheeseman, Kirk and Smith. Later writers have repeated the early records and I have been able to trace only one note during the intervening years, "Noted in waste land, Shannon, S. Mitchell.", published by Healy (1944). The Raglan record would seem to be the first for the Auckland Province.

POLYGONACEAE

Polygonum arenastrum Bor.

Auckland Domain, playing field, 1974, E. B. Bangerter 5161. Another specimen, Onewhero, Keal's Farm, 1965, P. Hynes, AK 104833, is in the Herbarium as *P. aequale* Lindm., under which synonym Allan (1940) gives some brief details of this segregate of the aggregate *P. aviculare L.* The nomenclature followed is that of Webb and Chater (1964). Further study of this complex is needed, including re-examination of herbarium material.

EUPHORBIACEAE

Euphorbia stricta L.

The only sheet of this species in the Herbarium is labelled Whangarei, south-west of Oakura Bay settlement, 1972, A. E. Orchard 3703. It does not appear to

be recorded in the earliest literature but Allan (1940) says "Occasional in waste places in Auckland City and Whangarei."

ESCALLONIACEAE

Escallonia montevidensis DC.

Glen Eden, Waikumete Cemetery, bank near crumbling monument, 1976, E. B. Bangerter 5297. This was taken in company with Mrs K. Wood and Miss S. Bowman who also collected the plant, which was subsequently identified by Mr A. E. Esler. Three other gatherings are in the Herbarium: Rangitoto, undated, L. M. Cranwell (possibly in the 1930s); Mt Hobson, Remuera, cultivated, 1948, S. A. Rose, AK 24516; Mt Hobson, overhanging Remuera Road, 1966, J. H. Goulding, AK 108864. I cannot trace records of this species in the literature, with the possible exception of *E. floribunda* (often confused with *E. montevidensis*, see Bean (1951)), offered for sale by D. Hay of Montpellier Nursery, Auckland, in his "Annual Calendar and Descriptive Catalogue for 1872".

ROSACEAE

Aphanes microcarpa (Boiss. & Reut.) Rothm.

Auckland, Mount Wellington, among short grass, 1975, E. B. Bangerter 5271. This gathering, made in company with Mr A. E. Esler and Miss Shirley Bowman, is the second in the Herbarium. *A. arvensis* L., in addition to the gathering cited by me (Bangerter 1975), is represented only by the Cheeseman specimens from Raglan cited by Healy (1954). More material is required to aid study of the distribution of these two species.

Filipendula ulmaria (L.) Maxim.

Stewart Island, Halfmoon Bay, frequent garden escape, 1963, P. Hynes, AK 92190. This is the only New Zealand specimen of this fragrant plant in the Herbarium and I have not been able to trace any record in the literature. It is common in the British Isles where it is known as "meadow-sweet". *F. hexapetala* Moench., the other well-known British species, has been recorded by Healy (1944). Nomenclature follows Clapham, Tutin and Warburg (1962).

PAPILIONACEAE

Vicia disperma DC.

Since my note last year (Bangerter 1975: 93) that Miss J. Goulding "has not observed this plant elsewhere in the Domain", she has twice found it in the area: Auckland Domain, under Eucalypts near cricket ground, 1975, J. H. Goulding 705; weedy edge of Domain Drive, 1975, J. H. Goulding 712. A further gathering, Browns Bay, 1975, E. B. Bangerter 5279, constitutes the first in the Herbarium from outside the Domain area. Another vetch, *Vicia hirsuta* (L.) S. F. Gray, somewhat similar though less robust, also has a two-seeded pod, which, however, is hairy and much smaller when mature than the glabrous pod of *V. disperma;* the former has nearly equal calyx-teeth, whereas those of the latter are unequal in length.

UMBELLIFERAE

Sison amomum L.

A recent addition is Waitemata, Glenfield, roadside, 1976, E. B. Bangerter 5300. From the few gatherings in the Herbarium, this plant, which I have not seen elsewhere than above, seems to have a scattered distribution and is not often listed in the literature. It was first recorded for New Zealand by Healy (1944).

RUBIACEAE

Galium parisiense L. var. *trichocarpum* Tausch.

Bay of Islands, c. 5½ km south of Kerikeri, 1973, T. A. Halliday 5. This is the first example of the variety in the Herbarium and Allan (1940) states that this variety is rare. It is characterised by pronounced bristles on the fruit. Other specimens of *G. parisiense* show either smooth or granular fruits.

CONVOLVULACEAE

Calystegia silvatica (Kit.) Griseb.

Auckland, Newmarket, in waste area, 1976, J. H. Goulding 721. This plant has the strongly inflated bracteoles typical of the species, and larger flowers than those of *C. sepium* (L.) R.Br. Healey (1969, 1973) lists *C. silvatica* as a species distinct from *C. sepium,* clearly accepting the former as adventive. Brummitt (1972), whose nomenclature is followed here, also treats *C. silvatica* as a separate species although it has been regarded by some British botanists as a subspecies of *C. sepium.*

LABIATAE

Mentha X citrata Ehrh.

Rotorua, Lake Rotoiti, 1959, D. V. G. Woods, AK 119286 as *M. aquatica* L.; Mairangi Bay, swampy area, 1975, E. B. Bangerter 5249; Remuera, J. H. Goulding, AK 117291. The last is a garden specimen. This hybrid (*M. aquatica* L. X *M. spicata* L.), known as Bergamot Mint, has a characteristic lemony scent. Healy (1958) says that it had previously been included by New Zealand authors under *M. aquatica.* He also comments that the only undoubted specimen of the latter species that he had seen was from the Bay of Islands, 1863, T. Kirk, in the Dominion Museum Herbarium, Wellington. The only specimen in the Auckland Herbarium labelled M. *aquatica* is a capitate mint with very hairy calyces collected by T. F. Cheeseman, AK 94259, undated, also from the Bay of Islands and therefore probably rightly named.

AMARYLLIDACEAE

Allium neapolitanum Cyr.

Auckland, Remuera, weed in vegetable garden, 1975, J. H. Goulding 608; Auckland Domain, gully, edge of tip, 1975, J. H. Goulding 609. I am unable to find any other records of this species as a horticultural weed or garden escape in New Zealand. Polunin (1969), who gave a description and illustration, is referred to for nomenclature.

Allium roseum subsp. *bulbiferum* (DC.) E. F. Warburg

Auckland Domain, weed in Museum courtyard, 1975, J. H. Goulding 618. This is the first example in the Herbarium of this plant and is the first record so far as I can ascertain for the North Island. Healy (1958) gives the first New Zealand record, from Christchurch, 1955, and notes that the sub-species is "characterised by the bulbils borne in the umbels with the flowers." He also lists the sub-species for the Canterbury area (Healy, 1969).

Tulbaghia violacea Harv.

Glen Eden, Waikumete Cemetery, among grasses at side of path, 1976, E. B. Bangerter 5298. This was taken in company with Mrs K. Wood and Miss Bowman, and Mr A. E. Esler kindly provided the determination for this specimen, which, he informs me, constitutes the first record for New Zealand.

IRIDACEAE

Lapeirousia laxa (Thunb.) N.E.Br.

Auckland, Parnell, growing wild under pines, privet and *Solanum,* 1975, E. G. Turbott, AK 138550; Whangaparaoa, Tindalls Beach, weedy garden, specimen grown in Auckland, Remuera garden, 1975, J. H. Goulding 704. These are the only representatives of this garden escape in the Herbarium and I cannot find any other records. Lawrence (1955) is the reference for nomenclature.

GRAMINEAE

Panicum dichotomiflorum Michx.

Mairangi Bay, in grounds of the Primary School, 1973, E. B. Bangerter 5013. The identification is confirmed by Dr J. F. Alex (University of Guelph). This is the only New Zealand specimen of this North American grass in the Herbarium. The species was first recorded by Healy (1946) from three stations in the North Island and he later (1973) describes it as a subtropical species adventive in cultivated land.

Acknowledgements. I am again indebted to Dr A. E. Orchard and Miss J. H. Goulding of the Auckland Institute and Museum staff for much assistance and advice in the preparation of this paper. To Mr A. E. Esler of D.S.I.R., Auckland, I am also grateful not only for the opportunity to participate in two field excursions but also for much general information on plants adventive in the Auckland area.

REFERENCES

ALLAN, H. H.

1940 A handbook of the naturalised flora of New Zealand. *N.Z. Dep. Scient. Ind. Res. Bull.* 83: 1-344.

BANGERTER, E. B.

1975 New and interesting records of adventive plants from the Auckland Institute and Museum Herbarium 1. *Rec. Auckland Inst. Mus.* 12:91-94.

BEAN, W. J.

1951 *Escallonia.* In *Royal Horticultural Society Dictionary of Gardening* Vol. 2, Chittenden, F. J. (Ed.) Clarendon Press, Oxford, pp. 781-782.

BRUMMITT, R. K.

1972 *Calystegia* R. Br. In *Flora Europaea* Vol. 3. Tutin, T. G. et al. (Eds.), University Press, Cambridge, pp. 78 - 79.

CLAPHAM, A. R., T. G. TUTIN and E. F. WARBURG

1962 *Flora of the British Isles.* 2nd ed. University Press, Cambridge, 1269 pp.

HEALY, A. J.

1944 Some additions to the naturalised flora of New Zealand. *Trans. Proc. R.Soc. N.Z.* 74:221-231.

1946 Contributions to a knowledge of the naturalised flora of New Zealand, No. 1. *Trans. Proc. R.Soc. N.Z.* 75: 399-404.

1954 Contributions to a knowledge of the naturalised flora of New Zealand, No. 4. *Trans. R.Soc. N.Z.* 82: 263-269.

1957 Contributions to a knowledge of the adventive flora of New Zealand, No. 5. *Trans. R.Soc. NZ.* 84: 649-659.

1958 Contributions to a knowledge of the adventive flora of New Zealand, No. 6. *Trans. R. Soc. N.Z.* 85:531-549.

1969 The adventive flora in Canterbury. In *The natural history of Canterbury.* G. A. Knox (Ed.) A. H. & A. W. Reed, Wellington, pp. 261-333.

1973 Introduced vegetation. In *The natural history of New Zealand.* G. R. Williams (Ed.) A. H. & A. W. Reed, Wellington, pp. 170-189.

LAWRENCE, G. H. M.

1955 Notes on *Lapeirousia* in cultivation. *Baileya* 3: 131-136.

N.Z. WEED and PEST CONTROL SOCIETY

1969 *Standard common names for weeds in New Zealand.* Editorial Services Ltd, Wellington. 141pp.

POLUNIN, O.

1969 *Flowers of Europe.* Oxford University Press, London. 662pp.

PRITCHARD, G. G.

1957 Experimental taxonomic studies on species of *Cardamine* Linn. in New Zealand. *Trans R. Soc. N.Z.* 85: 75-89.

SMITH, W. W.

1904 Plants naturalised in the county of Ashburton. *Trans. Proc. N.Z. Inst.* 36: 203-225.

WARDLE, P.

1975 Vascular plants of Westland National Park (New Zealand) and neighbouring lowland and coastal areas. *N.Z. J. Bot.* 13: 497-545.

WEBB, W. A., and A. O. CHATER

1964 *Polygonum* L. In *Flora Europaea* Vol. 1. Tutin, T. G. et al. (Eds.) University Press, Cambridge, pp. 76-80.

NOTES ON THE CHEESEMAN HERBARIUM

Part 3. Exchange with Australian herbaria from before 1900 to 1923

JEANNE H. GOULDING

AUCKLAND INSTITUTE AND MUSEUM

Abstract. Exchanges between T. F. Cheeseman and Australian herbaria are traced through specimens in the Auckland Institute and Museum Herbarium (AK) and through letters to Cheeseman in the manuscript collection of the Auckland Institute and Museum Library.

History of exchange

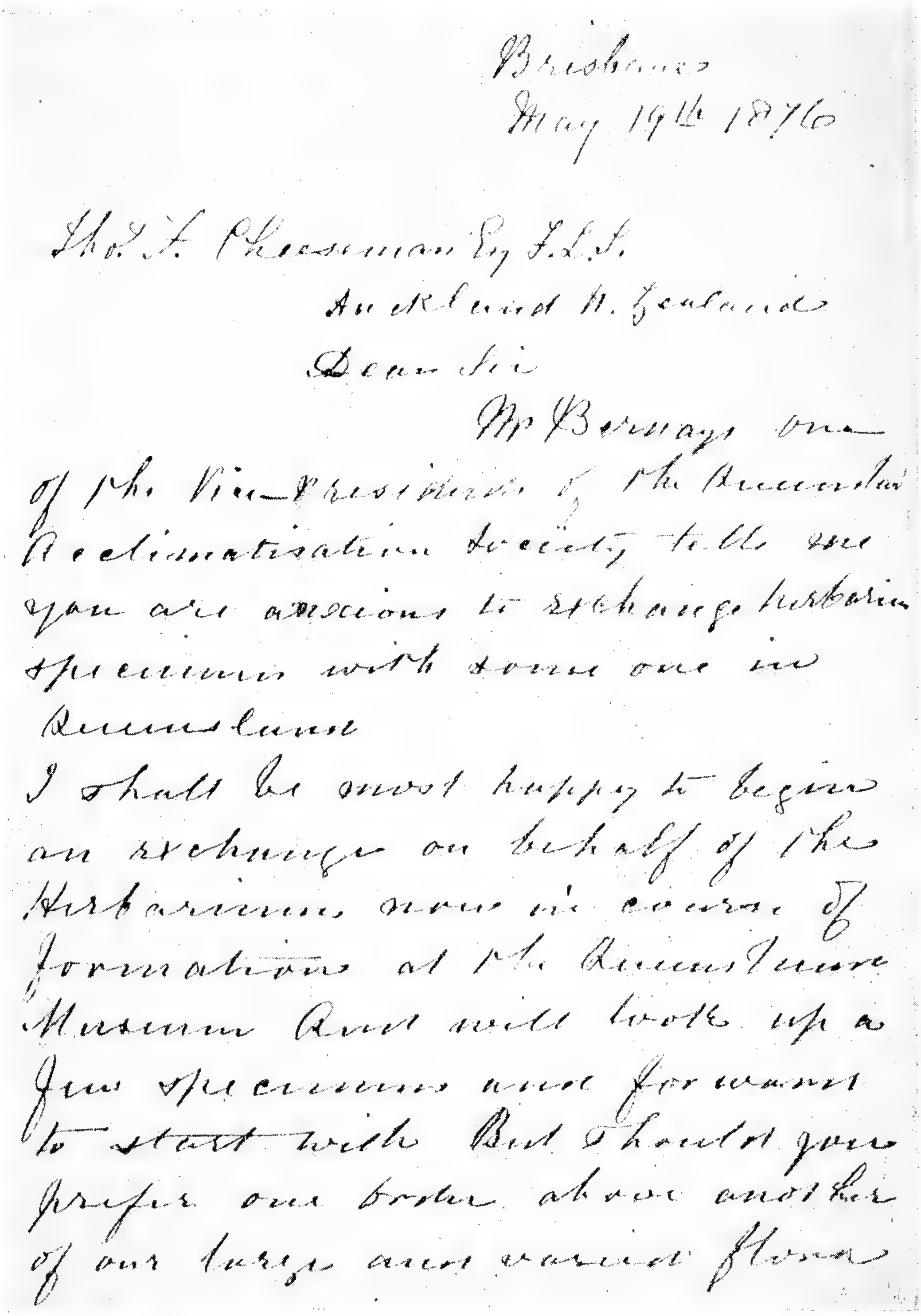
It is probable that Cheeseman's exchange of plant specimens with Australian herbaria began at much the same time as that with American and European herbaria, that is, in the late 1870s (Goulding 1974, 1975). In 1876, as secretary of the Auckland Acclimatisation Society, Cheeseman took the opportunity of letting Australian Acclimatisation Societies know of his desire to exchange plants. As a result, F. M. Bailey, then keeper of the herbarium at Queensland Museum, wrote from Brisbane: "Mr Bernay one of the Vice Presidents of the Queeensland Acclimatisation Society tells me you are anxious to exchange herbarium specimens with some one in Queensland" (Bailey to Cheeseman, 19 May 1876). In addition to the subsequent exchange with the main herbaria in Queensland, Victoria and New South Wales, early collections also came to Cheeseman at Auckland Museum via the Herbarium of the Royal Botanic Gardens, Kew — e.g. those of R. Brown and Tasmanian collections made by W. W. Spicer (Goulding 1975).

QUEENSLAND

Queensland Herbarium

Although not founded, officially, until 1880 (Holmgren and Keuken, 1974), the Queensland Herbarium, formerly Botanic Museum and Herbarium, Botanic Gardens, was being formed in 1876. At this time F. M. Bailey, signing himself "Keeper of Herbarium, Queensland Museum, Brisbane", wrote "on behalf of the Herbarium now in course of formation at the Queensland Museum" offering to exchange plant specimens with Cheeseman (Fig. 1).

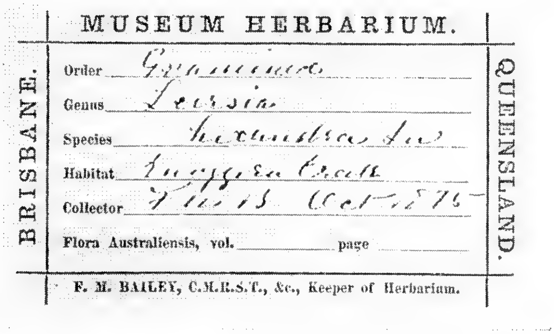
Frederick Manson Bailey (1827-1915), born in Hackney, England, emigrated to South Australia in 1838 when his father, John Bailey, was appointed Government Botanist and curator of a proposed botanic garden at Adelaide (not the present Botanic Garden of Adelaide). The botanic garden was very soon abandoned by the Government and John Bailey and his sons went on to establish a nursery in Adelaide. In 1858, F. M. Bailey left the family business and came to New Zealand where he took up land in the Hutt Valley. He returned to Australia in 1861 and opened a seed store in Brisbane, "and in addition he collected botanical specimens for sale to British and foreign Botanical Museums and Herbaria"



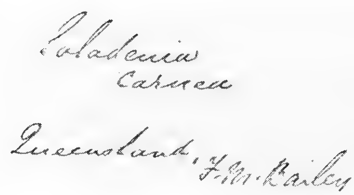
Brisbane
May 19th 1876

Thos. F. Cheeseman Esq F.L.S.
Auckland N. Zealand
Dear Sir
Mr Bernays one of the Vice-Presidents of the Queensland Acclimatisation Society tells me you are anxious to exchange herbarium specimens with some one in Queensland
I shall be most happy to begin an exchange on behalf of the Herbarium now in course of formation at the Queensland Museum and will look up a few specimens and forward to ~~start~~ with But should you prefer one order above another of our large and varied flora

Fig. 1. Portion of letter from F. M. Bailey, 19 May 1876.



2



3

Figs. 2,3 Herbarium labels. 2. Label of Brisbane Museum Herbarium, Queensland, F. M. Bailey, October 1875 (12.5 x 8.5 cm). 3. Label, written by Cheeseman, on a Bailey specimen (10.2 x 4 cm).

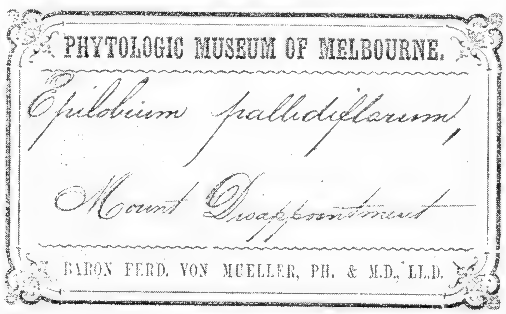


Fig. 4. Herbarium label ex Mueller: Phytologic Museum of Melbourne (13.5 x 8.5 cm).

(White, 1950). He was appointed, in 1875, to a Government board looking into the causes of disease of livestock and plants in Queensland and in 1880 was made Acting Curator of the Queensland Museum; in 1881 he was appointed Colonial Botanist, which title he held until his death in 1915 (White, 1950).

In his first letter to Cheeseman, May 1876, Bailey said he would like, in exchange for Australian specimens, "all you can send of the indigenous grasses." The grasses duly arrived in Brisbane the following July and Bailey forthwith asked for a packet of seed of any New Zealand grasses "having running stems" to introduce into Queensland (Bailey to Cheeseman, 2 September 1876). He subsequently sent species of Australian grassses to Cheeseman (Bailey to Cheeseman, 11 March 1877) and there are specimens in the Auckland Institute and Museum Herbarium complete with the old Brisbane Museum Herbarium labels (Fig. 2). However, there are many more, especially in Orchidaceae, of Bailey's collections labelled only in Cheeseman's hand (Fig. 3).

VICTORIA

National Herbarium of Victoria, Royal Botanic Gardens

Specimens from Ferdinand von Mueller from the Phytologic Museum of Melbourne (Fig. 4) constituted the first exchange between the present National Herbarium of Victoria and the Auckland Institute and Museum Herbarium.

Mueller, born in Germany in 1825, went to Australia in 1847 and became the first Government botanist of Victoria in 1853. He was appointed director of the botanical gardens at Melbourne in 1857, and supervised the building of what is now the National Herbarium of Victoria. When a curator was appointed to control the gardens in 1873 Mueller retained his position of Government botanist and continued in charge of the herbarium until his death in 1896.

From a letter to Cheeseman in 1882 it is apparent that Mueller was already receiving material from him. Mueller wrote, "It is very kind of you, dear Mr Cheeseman, to send me the fruit of Persoonia Toru. The specimens of drupes will answer my purpose very well." He also apologised for not "doing something in return for you" saying he had not had time to make up "any collections of spare specimens for a long time; but as gradually the accumulated and postponed work of my Department is cleared off, I shall also attend to the distribution of spare specimens of plants, and you shall not be forgotten." (Mueller to Cheeseman, 16 February 1882).

On Cheeseman's request, *Epilobium* species were sent to Auckland in 1895 and in his letter (Fig. 5) Mueller covered four foolscap pages in his large handwriting giving his views about *Epilobium* and *Coprosma* in Australia and New Zealand.

Several times Mueller asked Cheeseman for particular plants: "Zosteras in fruit or any other oceanic monocotyledonea" (Mueller to Cheeseman, 23 March 1888); *Alectryon excelsum* fruits and "authentic specimens of rarer kinds" of *Coprosma* (Mueller to Cheeseman, 8 August 1895). Seeds were also exchanged — Mueller offered eucalypts, "Can I send you seeds of rare Eucalypts from here or anything else? I could use seeds of your rarer Pittosporums." (Mueller to Cheeseman, 8 August 1896). As early as 1877 Mueller was sending Australian seeds to the Auckland Acclimatisation Society of which Cheeseman was then secretary (*Report of the Auckland Acclimatisation Society* 1877, p.13).

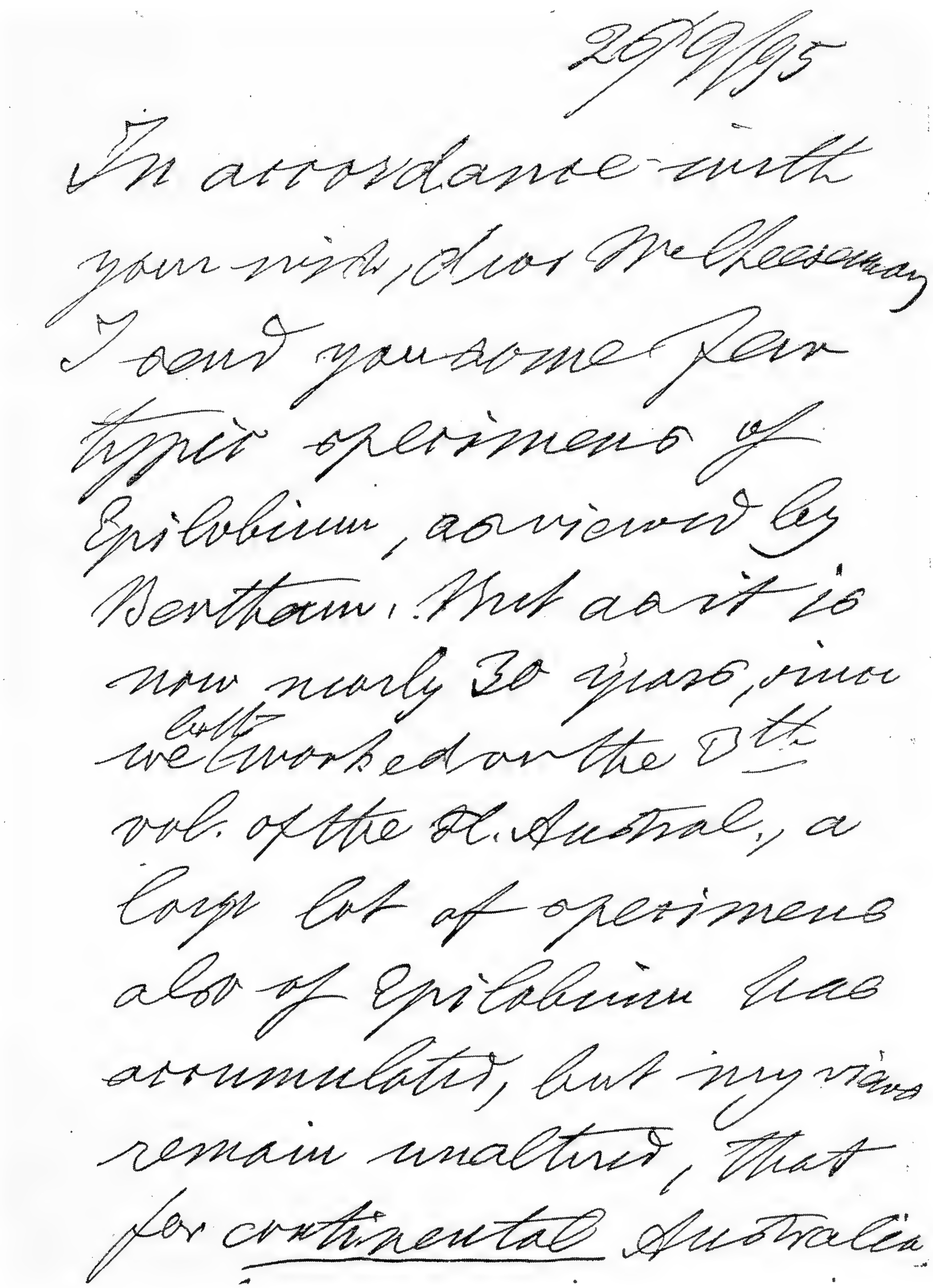
Collections ex Phytologic Museum of Melbourne were labelled by Mueller but often collected by others. Amongst the few specimens located in the Auckland Institute and Museum Herbarium are specimens of Perrot (Fig. 6), Spong, Mrs Wehl and Whan.

New South Wales

National Herbarium of New South Wales

The National Herbarium of New South Wales was founded in 1896 when J. H. Maiden was appointed Government Botanist and Director of the Botanic Gardens, Sydney.

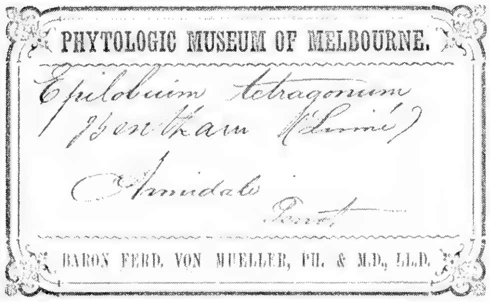
Joseph Henry Maiden (1859-1925) was born and educated in London and in 1880 sailed for New South Wales where he became Lecturer in Botany at the University of Sydney. In 1881 he was made first Curator of the Technological Museum of Sydney where he remained until 1896 when he moved to the newly-formed Sydney Botanic Gardens as Director, which position he retained until his



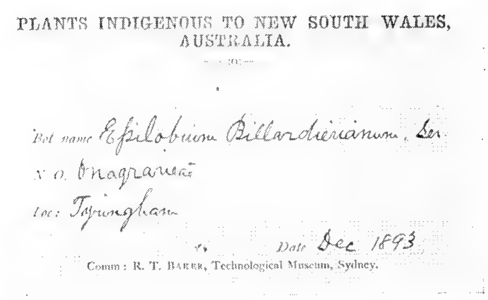
26/9/95

In accordance with your wish, dear Mr Cheeseman, I send you some few typic specimens of Epilobium, as viewed by Bentham. But as it is now nearly 30 years, since we both worked on the 3d vol. of the Fl. Austral., a large lot of specimens also of Epilobium has accumulated, but my views remain unaltered, that for continental Australia

Fig. 5. Portion of letter from F. von Mueller, 26 September 1895.



6



7

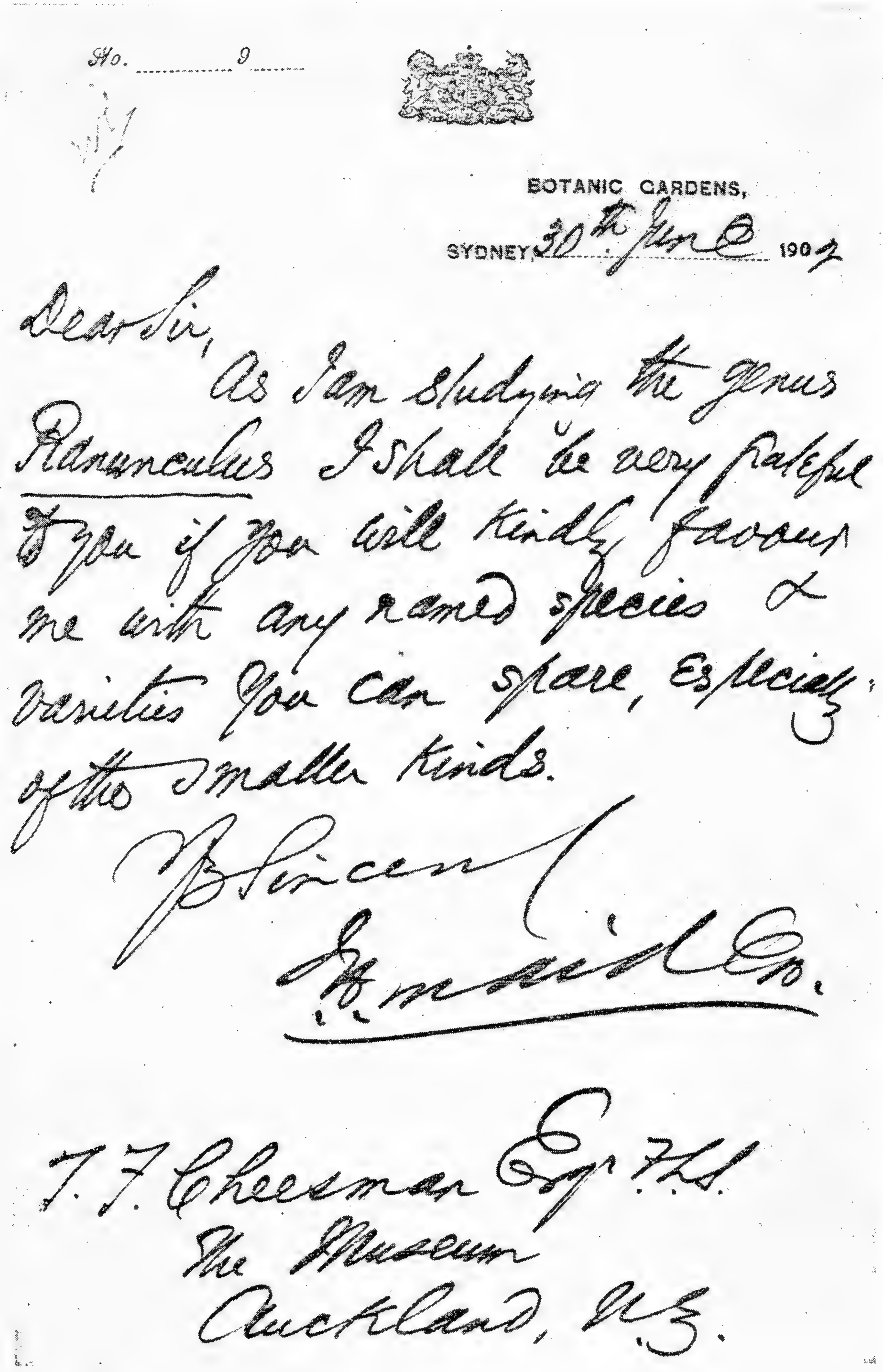
Figs. 6.7 Herbarium labels. 6. Label ex Mueller: Perrot collector (13.5 x 8.5 cm). 7. Label of R. T. Baker, December 1893, Technological Museum, Sydney (11.5 x 7.7 cm).

retirement in 1924 (Cambage, 1926). Presumably Maiden started an herbarium at the Technological Museum before he founded the National Herbarium at the Botanic Gardens. The only Technological Museum label on specimens in the Cheeseman Herbarium came from R. T. Baker (Fig. 7), probably with Maiden material, because there appears to be no correspondence between Baker and Cheeseman.

The first letter from Maiden to Cheeseman contained a request for an exchange of mosses on behalf of the "officer-in-charge" of the moss herbarium at the Botanic Gardens (Maiden to Cheeseman, 25 January 1900). Attached to a letter from Maiden, 29 July 1901, was a list of desiderata — of Australian plants which he thought would be of interest to Cheeseman and he intended to use when sending specimens to Auckland. The first fifty were sent later that year (Maiden to Cheeseman, 19 November 1901). In June 1902 Maiden asked Cheeseman to send him *Ranunculus* species (Fig. 8); in 1903 he asked for *"Olea apetala"* and in 1906 arranged for specimens of *Haloragis* to be sent to Cheeseman. Later correspondence, from 1915 to 1921, concerned the exchange of publications, but in 1916 more dried plants were sent to Auckland Museum. Maiden advised Cheeseman that he had forwarded 150 species of Australian plants (Maiden to Cheeseman, 22 March 1916) and a further 15 species were sent later in the year (Maiden to Cheeseman, 26 May 1916).

On the specimens sent by Maiden, now incorporated in the Auckland Institute and Museum, there are at least three types of labels: "Herbarium, Botanic Gardens Sydney" (Fig. 9); "National Herbarium of New South Wales" (Fig. 10) and those of Maiden's "Western Australian Journeys", 1909 (Fig. 11). Some of the National Herbarium labels appear to have localities and dates in Maiden's hand, but his name, as collector, is written in another handwriting (Fig. 10).

Many of the specimens sent by Maiden were from other collectors, including T. H. Adams, W. H. Blakely, F. Brown, J. L. Boorman, J. H. Camfield, W. Dunn, Rev. J. W. Dwyer, A. Granter, M. Gunn, R. Helms, J. Heron, M. Koch, C. Lampshire, A. H. Lucas, J. C. McMarter, L. Rodway, J. Rumsey, Rev. H. M. Rupp, and E. H. T. Swain.



No. 9

BOTANIC GARDENS,

SYDNEY, 30th June 1902

Dear Sir,

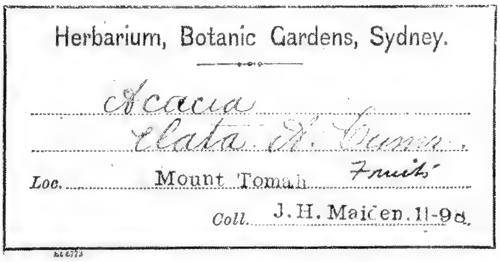
As I am studying the genus Ranunculus I shall be very grateful to you if you will kindly favour me with any named species & varieties you can spare, especially of the smaller kinds.

Yours sincerely

J H Maiden.

T. F. Cheeseman Esq. F.L.S.
The Museum
Auckland, N.Z.

Fig. 8. Letter from J. H. Maiden, 30 June 1902.

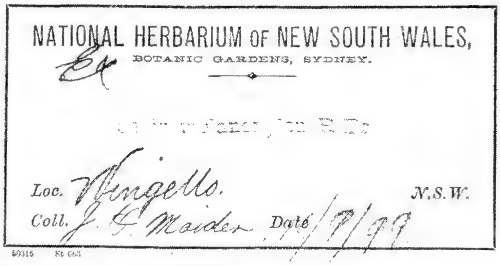

Herbarium, Botanic Gardens, Sydney.

Acacia elata A. Cunn.

Loc. Mount Tomah Fruits

Coll. J. H. Maiden. 11-98.

9


NATIONAL HERBARIUM OF NEW SOUTH WALES,

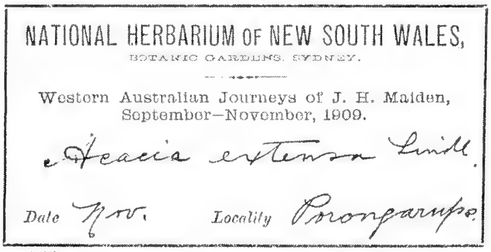
BOTANIC GARDENS, SYDNEY.

Ex

Loc. Wingello. N.S.W.

Coll. J. H. Maiden Date /9/99

10


NATIONAL HERBARIUM OF NEW SOUTH WALES,

BOTANIC GARDENS, SYDNEY.

Western Australian Journeys of J. H. Maiden, September–November, 1909.

Acacia extensa Lindl.

Date Nov. Locality Porongarup.

11

Figs. 9-11. Herbarium labels. 9. Label of Herbarium of Botanic Gardens, Sydney, J. H. Maiden, November 1898 (13.2 x 7 cm). 10. Label of National Herbarium of New South Wales, J. H. Maiden, 10 September 1899 (13.2 x 7 cm). 11. Label of J. H. Maiden, Western Australian Journeys, September-November 1909 (14.5 x 7.2 cm).

Conclusion

The National Herbarium of Victoria (MEL) is the only Australian herbarium listed by Lanjouw and Stafleu (1954, p.124) as having Cheeseman collections, although as seen above there are also holdings of his specimens in Brisbane (BRI) and Sydney (NSW). Exchange with Sydney continued for many years after Cheeseman's time, until about 1962, but present-day exchange is mainly with Adelaide (AD).

REFERENCES

CAMBAGE, R. H.

1926 Joseph Henry Maiden. 1859-1925. *Proc. R. Soc.* (B) 100: viii.

GOULDING, Jeanne H.

1974 Notes on the Cheeseman Herbarium Part. 1. Exchange with U.S.A. herbaria before 1900. *Rec. Auckland Inst. Mus.* 11: 105-117.

1975 Notes on the Cheeseman Herbarium Part 2. Exchange with European herbaria before 1900. *Rec. Auckland Inst. Mus.* 12: 95-120.

HOLMGREN, P. K. and W. KEUKEN

1974 Index Herbariorum Part 1, 6 ed. *Regnum vegetabile* 92: 1-397.

LANJOUW, J. and F. A. STAFLEU

1954 Index Herbariorum Part 2. Collectors A-D *Regnum vegetabile* 2: 1-174.

WHITE, C. T.

1950 F. M. BAILEY: his life and work: *Proc. R. Soc. Queensland* 61: 104-114.

REDISCOVERY OF GONOCARPUS TRICHOSTACHYUS (HALORAGACEAE)

A. E. ORCHARD

AUCKLAND INSTITUTE AND MUSEUM

Abstract. The rediscovery of a little-known species of *Gonocarpus* is reported, and the taxon is redescribed in the light of this new, more complete material.

In a recent revision of *Gonocarpus* (Orchard 1975: 234-235), one of several taxa that could not be adequately dealt with because of lack of material was the Western Australian species *Gonocarpus trichostachyus* (Benth.) Orchard. The only collections known were the type, collected by Drummond about 1848, without locality, and another collected by Cronin in 1890 from "near Lake Wagin" (now the town of Wagin). Both of these collections were of poor quality, with only a few fruits and no complete flowers.

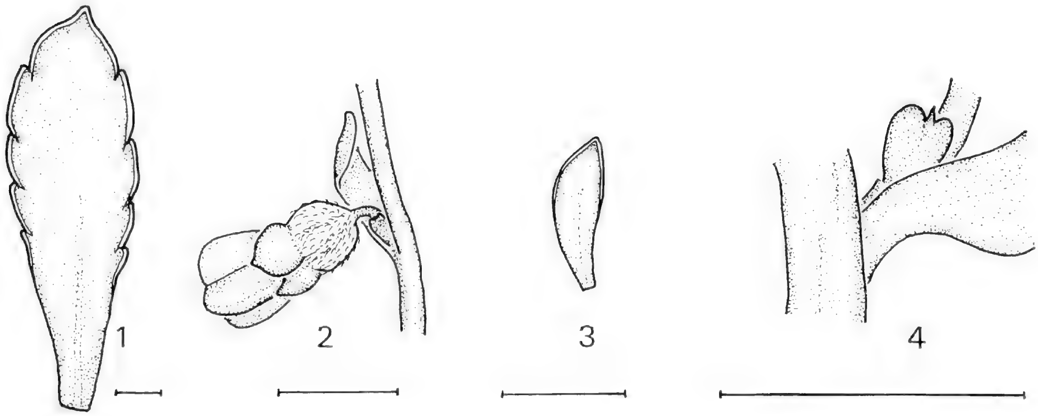
A further collection (*R. D. Royce 9305,* 24. x. 1970, low perennial in sandy soil along Vermin Fence near N. boundary Fitzgerald River National Park, AK, PERTH) has recently been made, consisting of good, although slightly immature, flowering material. On the basis of this new collection the species is redescribed in detail below.

Erect annual or perennial herb to 17 cm tall; stems olive-green to red-brown, not ribbed, older stems glabrous, younger stems with sparse to moderately dense, appressed, white unicellular (occasionally 2-celled) hairs 0.1-0.2 mm long.

Leaves decussate, sessile, oblanceolate, 0.7-1.0 cm long, 1.5-3.0 mm wide, midrib faint, other veins obscure; margins thickened, hyaline, crenulate; lamina glabrous or sparsely appressed pilose, mainly on the margins and midrib of the lower surface, with hairs as for stems (Fig. 1).

Inflorescence an indeterminate spike of flowers borne singly in the axils of alternate primary bracts. Lateral inflorescences arise in axils of reduced upper leaves, and are themselves often branched. Ultimate branches of infloresence reddish, filiform, tips nodding. Primary bracts reddish, lanceolate to oblanceolate, 1.0-1.3 mm long, 0.3-0.4 mm wide, entire, ± glabrous. Secondary bracts red-purple to brown, ovate to obcordate, with short mucro in notch at apex, 0.3-0.4 mm long, 0.2-0.3 mm wide, glabrous (Figs. 2-4).

Flowers 4-merous on pedicels 0.4-0.5 mm long, pendulous. Sepals 4, reddish-green, ovate to orbicular, 0.4-0.5 mm long, 0.4-0.5 mm wide, very weakly midribbed, glabrous. Petals 4, deep reddish-purple, hooded with incurved tip, keeled, non-unguiculate, 0.9-1.1 mm long, 0.3 mm wide, ± glabrous or very sparsely appressed pilose on keel. Stamens 8; anthers yellow to reddish, linear-oblong, 0.6-0.9 mm long, 0.2 mm wide, 4-locular, non-apiculate. Styles 4, clavate; stigmas red, capitate. Ovary black, turbinate, 0.6 mm long, 0.7 mm wide, with 8 very weak longitudinal ribs, ±



Figs. 1-4. *Gonocarpus trichostachyus*. 1. Leaf. 2. Portion of inflorescence showing a flower in the axil of a primary bract. 3. Primary bract. 4. Detail of axil of primary bract, showing secondary bract at base of pedicel. All figures from *Royce 9305*. Scales represent 1 mm.

densely appressed pilose particularly on ribs, incompletely 4-locular with 1 pendulous ovule per locule.

Fruits on pedicels 0.2-0.5 mm long, dark grey to black, ovoid to turbinate, 0.8-0.9 mm long, 0.6-0.7 mm wide, not or scarcely ribbed, scabrous; sepals persistent, erect, reddish, ovate, 0.6 mm long, 0.6 mm wide, obtuse, enclosing styles; pericarp membranous, 1 seed.

The dimensions given above for the parts of the flower are based largely on buds before anthesis. It is likely that they will have to be increased slightly when fully developed flowers are available. This should remove the large (for *Gonocarpus*) discrepancy between the dimensions given for the ovary and the fruit.

This new collection provides the opportunity for some general comments to be made regarding the distribution and probable relationships of *G. trichostachyus*. In general appearance, habit and colouration, this plant closely resembles *G. paniculatus*, particularly those forms with slightly flattened leaves. The major points of difference between the two species are in their height (up to 17 cm in *G. trichostachyus;* 40-60 cm in *G. paniculatus*), and in their leaf shape (oblanceolate in *G. trichostachyus;* terete to narrow-linear in *G. paniculatus*). In this last character *G. trichostachyus* more closely resembles *G. rudis,* but differs from the latter in having 1(-2)-celled, appressed white hairs instead of the 5-7-celled spreading reddish hairs of *G. rudis*. Both *G. rudis* and *G. trichostachyus* have been found in very much drier habitats than *G. paniculatus* but have the appearance of being closely related satellites of that more palustrine plant.

There is now a considerable gap in the known distribution of *G. trichostachyus* (from Wagin to Fitzgerald River National Park) and it is to be hoped that further collections can be found to fill it.

REFERENCE

ORCHARD, A. E.

1975 Taxonomic revisions in the Family Haloragaceae I. The genera *Haloragis, Haloragodendron, Glischrocaryon, Meziella* and *Gonocarpus*. *Bull. Auckland Inst. Mus.* 10: 1-299.

THE TAXONOMY OF SOME INDO-PACIFIC MOLLUSCA

Part 4. With descriptions of new taxa and remarks on *Nassarius coppingeri* (Smith)

W. O. CERNOHORSKY

AUCKLAND INSTITUTE AND MUSEUM

Abstract. New species of *Mitra* from Moreton Bay, Australia, *Vexillum* (*Pusia*) from Hawaiian Islands, and a *Muricopsis* from the Indian Ocean are described as new to science. *Murex noduliferus* Sowerby, and *M.euracanthus* A. Adams, are defined on the basis of their type-specimens. *Purpura ochrostoma* Blainville, usually assigned to the genus *Drupella* Thiele, and *Ergalatax contractus* (Reeve), are re-assigned to *Cronia* H. & A. Adams, on the basis of their radulae. *Phos textilis* A. Adams, is recorded from the Pacific, and the West American *Nassarius miser* (Dall), is synonymised with *N.coppingeri* (E. A. Smith).

Family MITRIDAE Swainson, 1831

Genus **Mitra** Lamarck, 1798

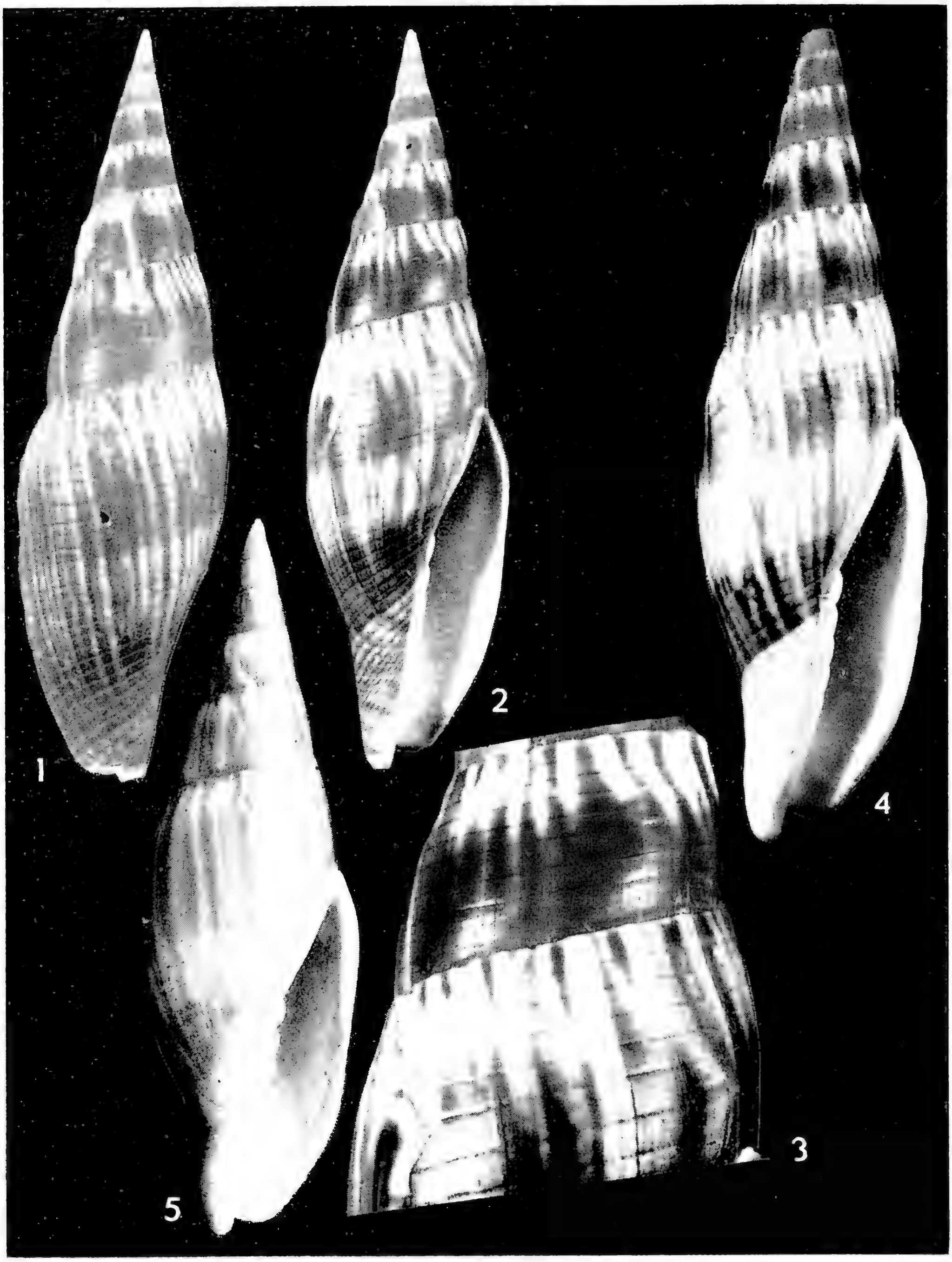
Mitra Lamarck, 1798, Tabl.Encyl.Méth. pl. 369 Type species by *T Voluta mitra* Linnaeus, 1758 (Opinion 885 of ICZN). Recent, Indo-Pacific.

Mitra hilli sp. n (Figs. 1-5)

Shell moderately large, 80.0-130 mm in length, fusiformly-elongate, width 26%-31% of length, moderately light in weight, teleoconch of 8-10 weakly convex whorls, protoconch with $2\frac{1}{4}$ smooth, conoidal embryonic whorls, sutures tight and very narrowly ledged. Early whorls sculptured with 8-9 finely incised and minutely punctate spiral grooves; penultimate whorl with 9-12 spiral grooves and body whorl with 23-27 grooves, grooves finely axially striate on last two whorls through dense, overriding macrostriae. Aperture about equal in height to the spire, height 45%-51% of length, smooth within, outer lip convex in immature specimens but thick and straighter in mature individuals and forming a narrow calloused edge on the back of the outer lip, columella narrowly calloused and with 5-6 strong, oblique folds; siphonal notch distinct, siphonal canal longer than outer lip, slightly twisted and recurved towards body whorl, siphonal fasciole with 11-12 close-set, oblique cords. White in colour, ornamented with narrow, slightly wavy brown axial stripes, anterior two-thirds of spire whorls with a broad brown transverse band, body whorl with two bands, aperture porcellaneous-white. Periostracum light brown in colour and moderately translucent.

TYPE LOCALITY. 26 - 29 km north of Cape Moreton, Sth. Queensland, Australia, in 132 metres.

DISTRIBUTION. From Queensland, Australia to S.W. Taiwan, 112 - 155 m.



Figs. 1-5 *Mitra hilli* sp.n 1-4. Nth. of Cape Moreton, Qld., Australia, 121-132m. 1, 2. Holotype AIM No. TM-1344, 111.6 x 31.0 x 54.7 mm. 3. Last two whorls enlarged. 4. Paratype 109.6 x 31.8 x 56.0 mm. 5. Paratype from Taiwan, 155 m; 79.6 x 24.5 x 41.0 mm (coll. P. Clover).

Holotype. In the Auckland Institute and Museum, Auckland, No. TM-1344; length 111.6 mm, width 31.0 mm, height of aperture 54.7 mm (Figs. 1-3). The holotype is slightly immature and has a small predator hole on the dorsal side of the body whorl.

Paratypes. In coll. Bill Hill (127.4 x 33.5 x 63.9 and 111.0 x 31.0 x 53.0 mm); J. Tilton (103.0 x 29.5 x 50.1 mm); J. Mewburn (99.0 x 29.5 x 46.0 mm); J. Grady (87.4 x 25.5 x 43.0 mm); D. Vickers (100.7 x 28.9 x 53.2 mm); B. Davis (110.0 x 29.0 x 50.0 and 109.0 x 28.0 x 49.0 mm); R. Evans; and P. Clover (79.6 x 24.5 x 41.0 mm — specimen from Taiwan, Fig. 5).

Mitra hilli has been dredged in several Moreton Bay localities, ranging from 16 - 40 km north of Cape Moreton, at depth from 112 - 152 m. The solitary specimen from Taiwan came from a depth of 155 m. *M.hilli* is superficially similar to *M.triplicata* v.Martens, 1904, from the East Africa - Philippines region, but is twice as large (average size of *M.hilli* is 100 - 110 mm, of *M.triplicata* 45 - 55 mm), and occurs in considerably shallower waters than *M.triplicata* (*M.hilli* 112 - 155 m and *M.triplicata* 476 - 1362 m). The sculpture of *M.triplicata* is appreciably different and is usually coarser, with deeper, more coarsely pitted spiral grooves and 2-4 elevated cords at the body whorl suture; it is also less fusiform, the columellar callus is broader anteriorly, columellar folds number from 3-5, and the colour is uniformly tan to dark brown, and lacks the banded and striped pattern of *M.hilli*. The periostracum in *M.hilli* is light brown and translucent, while in *M.triplicata* it is thicker, more opaque and dark brown. Another somewhat similar species is *M.nivea* (Broderip, 1836), but it can be separated from *M.hilli* by its fenestrate sculpture on the very early spire whorls and the very numerous spiral striae which number from 35 - 70 on the body whorl; adult specimens of *M.nivea* are uniformly white to fawn in colour, and the sutures are occasionally minutely spotted with dark brown.

An unusual feature of *M.hilli* are the repaired breaks visible as scars on every specimen examined. Usually two break-scars are present on each shell, one on the spire whorls and one on the body whorl. The same scar is also present on the specimen from Taiwan.

The species has been named for Mr Bill Hill, Mooloolaba, Australia, who collected a series of specimens from Moreton Bay for study and description.

Family COSTELLARIIDAE Macdonald, 1860

1857. Turritidae Gray, Guide syst.distr.Moll.Brit.Mus. p.23 (for *Turris Montfort*, 1810 (*non* Roeding, 1798) — not available, Art.lle and 63 of ICZN).

1860. Costellariidae Macdonald, Trans.Linn.Soc.Lond. 23:81; 1861 Troschel, Arch.f.Naturg. 27(2):179.

1861. Turriculidae Carpenter,Ann.Repts.Smiths.Inst.Gen.App. p.178 (for *Turricula* Fabricius, 1823 (*non* Schumacher,1817) — not available, Art.lle and 63 of ICZN).

1929. Vexillinae Thiele, Tandb.syst.Weich. 1:337.

1961. Pusinae Habe, Coll.Illust.shells Japan 2:69.

The family-group name Vexillidae Thiele, has appeared in a few malacological publications post 1961, and has been utilised as a separate family from the Mitridae for the generic units *Vexillum, Costellaria, Pusia, Thala* and

Zierliana. The family-group name Vexillidae, however, has been used only twice prior to 1961, and cannot therefore be considered to have been in "general current use", as defined by the 10 times usage criteria in Declaration 43 of the International Commission on Zoological Nomenclature (1970). Vexillidae Thiele, 1929, will have to be replaced by the chronologically prior Costellariidae Macdonald, 1860.

Genus **Vexillum** Roeding, 1798

Subgenus **Pusia** Swainson, 1840

Pusia Swainson, 1840, Treat.Malac. p.320. Type species by M *P.microzonis* (Lamarck) = *Mitra microzonias* Lamarck, 1811. Recent, Indo-Pacific.

Vexillum(Pusia)salisburyi sp. n. (Figs. 6 - 9, 11)

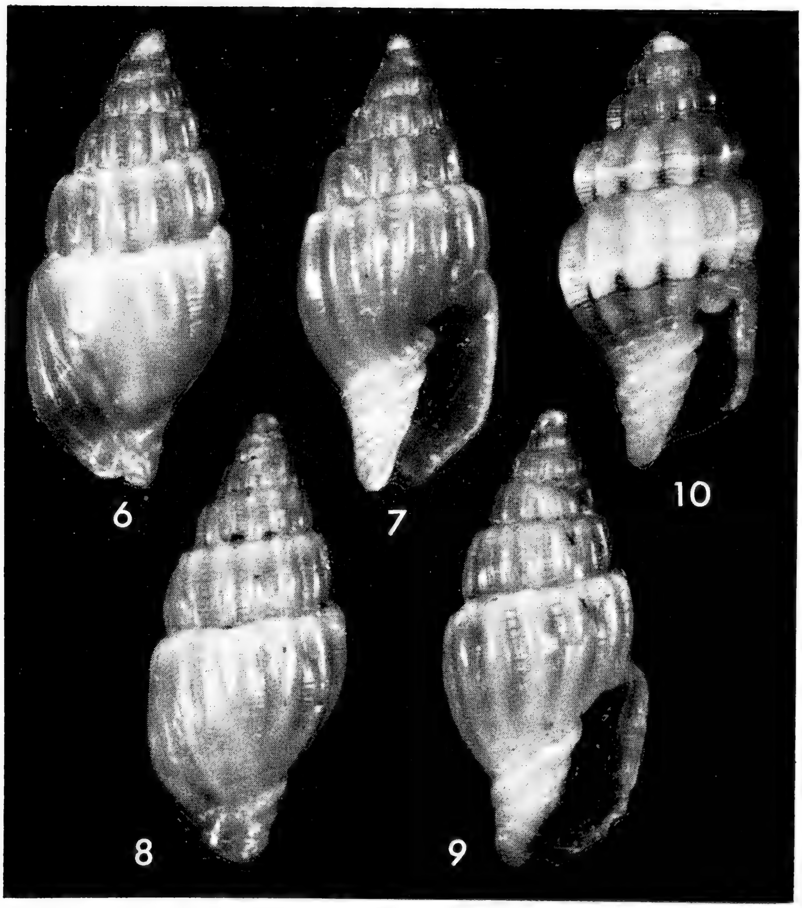
Shell minute, up to 6.0 mm in length, elongate-ovate, width 42%-47% of length, moderately solid, teleoconch of $4\frac{1}{2}$-$4\frac{3}{4}$ weakly convex whorls which become roundly angulate at the presutural ramp, protoconch of $1\frac{1}{2}$ smooth, glassy, typically pusiine embryonic whorls; sculptured with strong, roundly angulate axial ribs which number from 11-15 on the penultimate and from 6-12 on the body whorl, axial ribs usually becoming obsolete on the dorsal side of the body whorl particularly nearer the outer lip; interspaces of axial ribs with distinct, finely impressed spiral striae. Aperture about equal in height to the spire, height 47%-54% of length, narrow, interior lirate, edge of outer lip slightly constricted basally, parietal wall with callous-pad in adult specimens, columella with 4 oblique folds which decrease in size anteriorly and extend as prominent cords onto the siphonal fasciole; siphonal canal straight, siphonal notch distinct. Dark orange-brown, pinkish-brown or rose in colour, sutures of last two whorls frequently slightly paler rose-pink, aperture rose-brown.

TYPE LOCALITY. Pupukea beach, Oahu, Hawaiian Is, in beach-sand.

Holotype. Auckland Institute and Museum No.TM-1345; length 5.3 mm, width 2.3 mm, height of aperture 2.8 mm (Figs. 6, 7).

Paratypes. In the National Museum of Natural History, Smithsonian Institution, Washington; the Delaware Museum of Natural History, Greenville; the Academy of Natural Sciences, Philadelphia; the Bernice P. Bishop Museum, Honolulu; coll.G.Lindner, Hamburg; coll.H.Eker, Sanibel I, and the remaining 63 paratypes are in coll.R.Salisbury, Honolulu.

This minute species has been recently collected in large numbers in beach-sand in the Hawaiian Is. Most specimens examined, had a small part of the outer lip broken off, and in indivduals with a complete outer lip, a distinct repair scar showed that a portion of the aperture had been replaced after injury. This weakness of the outer lip has been observed in *V.(P.)turben* (Reeve), *V.(P.)suavis* (Souverbie) and other small *Pusia* species, and is not an exclusive feature of *V.(P.) salisburyi*. This new species has been confused with *V.(P.)rubrum* (Broderip, 136), particularly the plain orange-buff colour-variant, but this species, although similar in size and sometimes colouring, differs in the prominently convex, swollen whorls. (Fig. 10).



Figs. 6-10. 6-9 *Vexillum* (*Pusia*) *salisburyi* sp.n.; Pupukea Beach, Oahu, Hawaiian Is. 6, 7. Holotype AIM No. TM-1345; 5.3 x 2.3 x 2.8 mm. 8, 9. Paratype 5.4 x 2.5 x 2.6 mm (coll. Salisbury). 10. *V.* (*P*) *rubrum* (Broderip); Fiji Is, 8.2 x 4.0 x 3.7 mm.

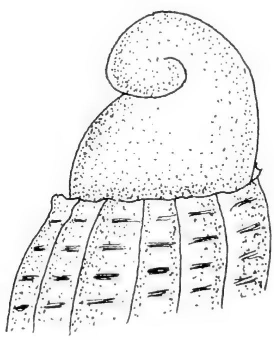


Fig. 11. *Vexillum* (*Pusia*) *salisburyi* sp.n. Protoconch.

The species has been named for Mr Richard Salisbury, Honolulu, a keen student of the family Mitridae, who has collected numerous specimens in the Hawaiian Islands, and recognised the distinction from other, related species.

Family MURICIDAE Rafinesque, 1815

Genus **Muricopsis** Bucquoy, Dautzenberg & Dollfus, 1882

Muricopsis Bucquoy, Dautzenberg & Dollfus, 1882, Moll.Mar.Roussillon, 1:16,19. Type species by OD *Murex blainvillei* Payraudeau, 1826. Recent, Mediterranean.
1852. *Muricidea* Moerch, Cat.Conchyl.Yoldi, 1:95 (*non* Swainson, 1840).
1915. *Murexsul Iredale,* Trans.N.Z.Inst. 47:471. Type species by OD *Murex octogonus* Quoy & Gaimard, 1833. Recent, Australia and New Zealand.

Muricopsis orri sp. n. (Figs. 12-20)

Shell moderately small, 27.0 mm in length, solid, spire pointed, sutures adpressed and undulate, teleconch of 7-7¼ mature, convex whorls which are subangulate on presutural ramp, protoconch of 1½ smooth embryonic whorls. Varices coarse and thick, numbering from 5-7 on the body whorl, spire whorls with a single spine extending from the varix at the presutural ramp, body whorl with 4 rows of main spines, 2 central spines slightly shorter than adjacent top and bottom spines; first row of spines slightly curved upward, fourth row pointing downward, spines connected by 4 main spiral chords to neighbouring varices, remainder of shell-surface sculptured with numerous, fine and slightly gemmate or scaly spiral striae. Spines emanating from sutures in a broad growth, spine-surface at this point sculptured by oblique axial rows of prickly scales. Aperture small, oviform, apertural rim well elevated above shell-surface, outer lip with 6-8 prominent denticles which continue as lirae into the aperture, columella prominently calloused and with 2-4 small denticles anteriorly; outer lip usually with 4 main spines and occasionally smaller intermediate spinelets, right side of siphonal canal without spines, siphonal fasciole with 2 longer and 1 short spine, siphonal canal moderately short, open, and recurved towards the dorsum. Usually brown in colour, sometimes yellowish-brown, edges of varices and sutural scales whitish, aperture white or pale violet within. Operculum orange-brown, moderately thin and with a terminal nucleus.

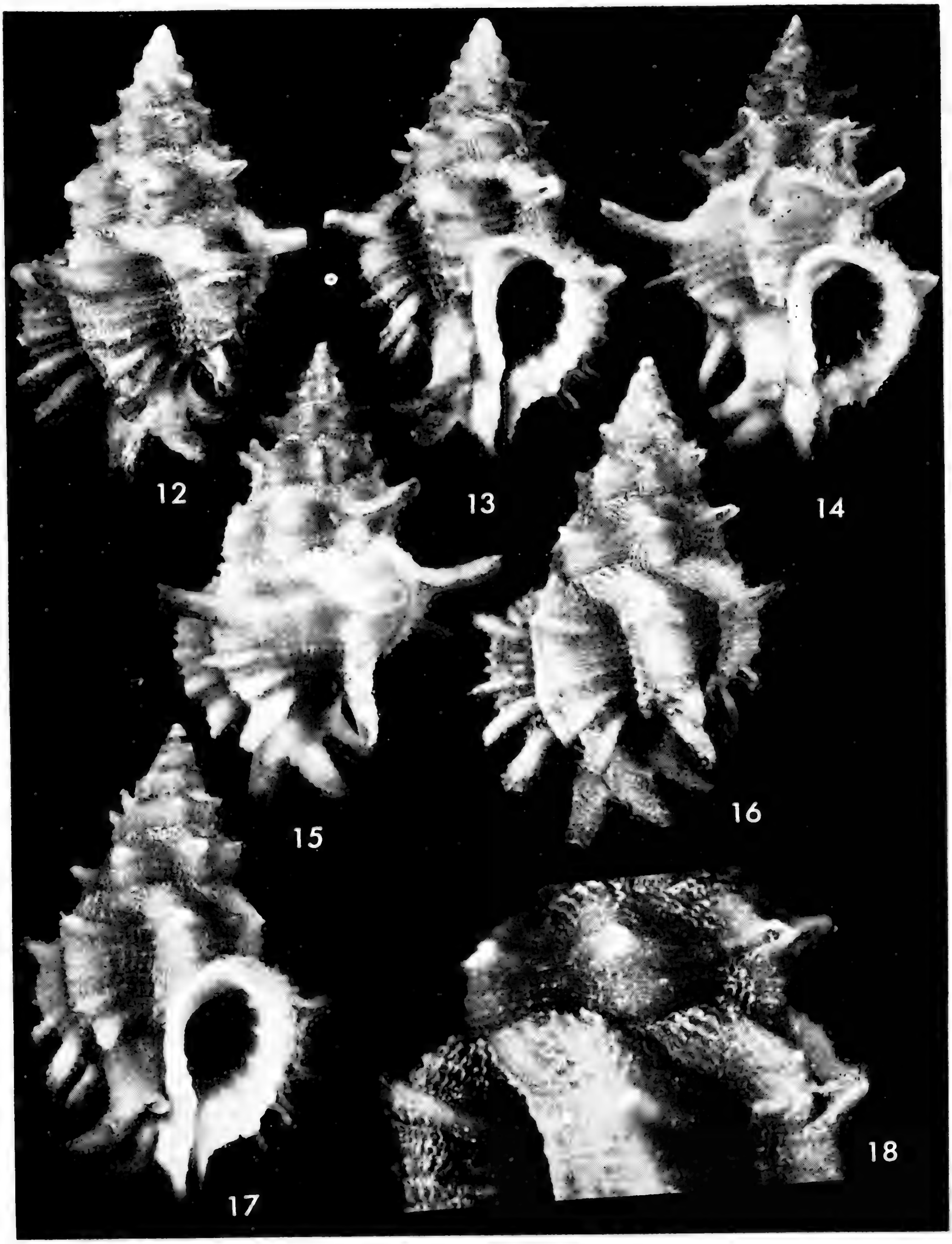
TYPE LOCALITY. South of the Andaman Islands, Indian Ocean, in 55 metres.

DISTRIBUTION. From the Andaman Is to the west coast of Thailand.

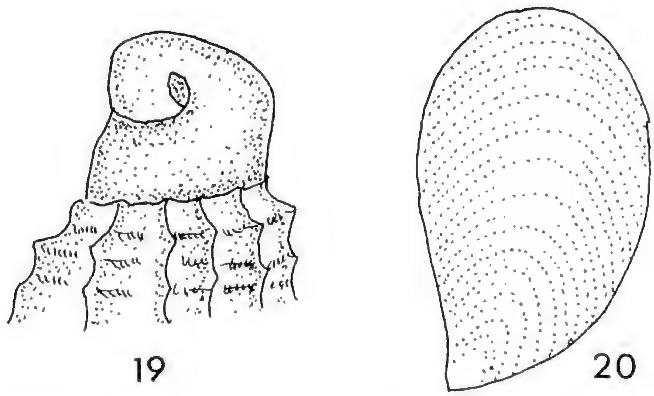
Holotype. In the Auckland Institute and Museum, Auckland, No. TM-1346; length 27.1 m, width 18.6 mm (spines excluded) (Figs. 12, 13).

Paratypes. Paratypes No.'s 1-3, dimensions 32.5 x 20.0 mm, 29.1 x 22.0 mm, and 29.0 x 20.2 mm, (Figs. 14,15) are in coll.E. Wright, Sanibel Island; paratype No. 4, 32 x 22.8 mm, from Krabe, S.W. coast of Thailand, is in the author's collection (Figs. 16-18).

This new species has been labelled in collections as *Muricopsis infans* (E.A. Smith,1884). Smith's holotype of *Murex(Ocenebra)infans,* Brit.Mus.(Nat.Hist.) No. 1882.12.6.133, is a minute, 8.0 mm long species from the Amirantes Is, (E. A. Smith, 1884) which bears little resemblance to *Muricopsis orri,* and could possibly belong to *Cronia* rather than *Muricopsis* (Fig. 21). *M.orri* resembles in some



Figs. 12-18. *Muricopsis orri* sp.n. 12-15. Sth. of the Andaman Is, 55 m. 12, 13, Holotype AIM No. TM-1346, 27.1 x 18.6 mm. 14, 15. Paratype 29.0 x 20.2 mm (coll. E. Wright). 16-18. Krabe, S.W. coast of Thailand. 16,17. Paratype 32.2 x 22.8 mm. 10. Last two whorls enlarged.



Figs. 19, 20. *Muricopsis orri* sp.n. 19. Protoconch. 20. Operculum.

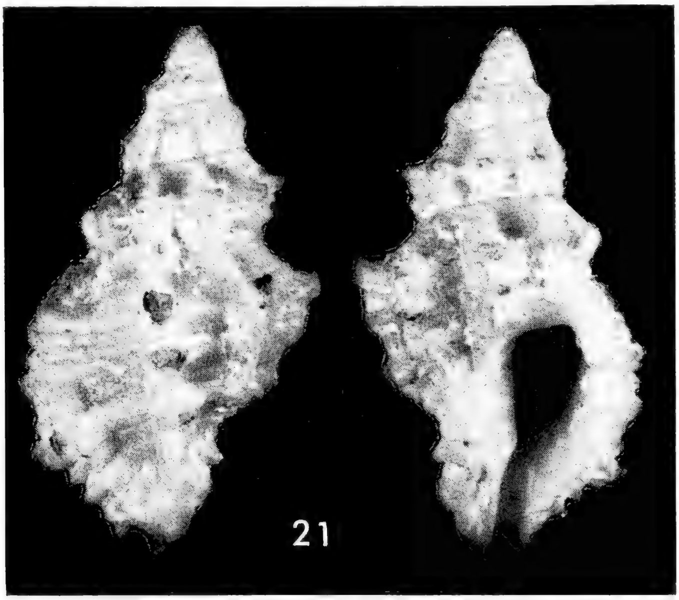


Fig. 21. *Murex (Ocenebra) infans* E. A. Smith, Amirantes Is. Holotype BMNH No. 1882.12.6.13., 8.0 x 4.3 mm.

ways *"Muricopsis cuspidatus* Sowerby" of Ponder (1972), but in *M.orri* the spire whorls are more angulate, the varices thick and prominent, the spines become erect on the presutural ramp and the right side of the siphonal canal always lacks spines. Some doubt exists that Ponder's *"Muricopsis cuspidatus"* is conspecific or even congeneric with Sowerby's species. The type-specimen of *Murex cuspidatus* Sowerby, 1879, from Japan can no longer be traced in the type-collection of the British Museum (Nat. Hist.), London, but the type-figure shows a species with 8 rows of equal-sized spines and not 4 like in the Australian species, the columella is round and concave, and the siphonal fasciole has a bulging fasciolar flat pad with 5 short spines on the edge. *M.cuspidatus* Sowerby, is probably not even a *Muricopsis* but bears a close resemblance to species of *Chicoreus* or *Hexaplex,* and has been assigned to the latter group by Vokes (1971).

The species has been named for Mr John Orr, currently of Hong Kong, who has collected the species in Thailand several years ago.

Muricopsis noduliferus (Sowerby, 1841) (Figs. 22-26)

1841. *Murex noduliferus* Sowerby, Conch.Illust.*Murex,* pl.194,fig.94; 1841 Sowerby, Proc. Zool.Soc.Lond. Pt.8:147.

1849. *Murex(Trophon)fruticosus* Gould, Proc.Boston Soc.Nat.Hist. 3:143; 1852 Gould, U.S. Exped. 12:236,pl.17,figs.287,287a (immature specimen).

1880. *Murex(Phyllonotus)noduliferus* Sowerby,Tryon,Man.Conch. 2:111,pl.30,figs.282,288.

1963. *Drupa(Morula)nodulifera* Sowerby,Shikama, Select.shells world col. 1:pl.59,fig.1.

1967. *Poirieria nodulifera* (Sowerby),Cernohorsky,Veliger,10(2):125,pl.15,fig.17; 1967 Cernohorsky, Mar.shells Pacific 1:128,pl.27,fig.166.

1971. *Muricopsis noduliferus* (Sowerby),Vokes,Bull.Americ.Paleont. 61(268):75.

TYPE LOCALITIES. Masbate I, Philippine Is(*M.noduliferus*); Sydney, Australia, = error? (*M.fruticosus*).

The re-description which follows, has been based on Sowerby's type-specimens and live-collected examples from the Fiji and Tonga Is.

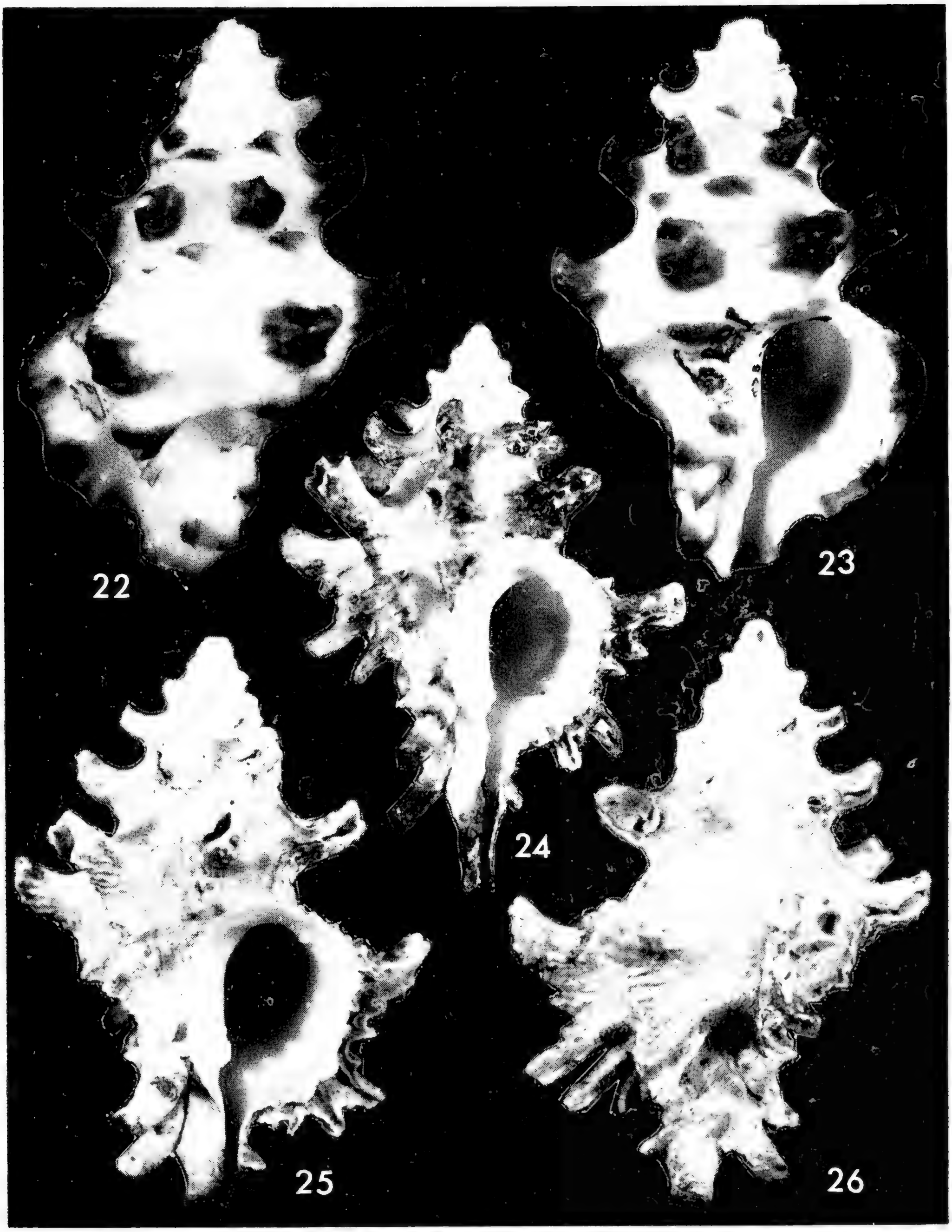
Shell up to 32 mm in length, light in weight, spire conical, sutures fully adpressed and prominently wavy, varices numbering from 6-7 on the body whorl and from 6-8 on the penultimate whorl; sutures and presutural ramp conspicuously smooth, spire whorls sculptured with 1 row of centrally placed, extended, and occasionally curved open spines, centre of body whorl with 3 spiral rows of spines which decrease in size anteriorly, third row of spines adjacent to second row, and a fourth row of spines occasionally present; spiral sculpture almost absent except for very obsolete spiral cords between the main fronds on the body whorl. Siphonal fasciole with 1 row of small spines and 3 curved spines anteriorly, siphonal canal produced, recurved and slightly open, and with a small spine situated on the right side of the siphonal canal; aperture small, oviform, and with a prominent laminated callus, outer lip varix with three main spines and 1-2 intermediate spinelets, edge of outer lip angulate and with more than a dozen small spinose denticles, interior of aperture with 5-7 prominent denticles, columellar pad elevated above body whorl, base of columella with 0-4 (usually 2-3) small denticles. Uniformly white or cream in colour, end of spines occasionally brown, aperture white or creamy-yellow.

Sowerby's two syntypes, one of them immature, are in the Brit.Mus.(Nat. Hist.) London, No. 1842.5.10(1618-1619) (Figs.22,23), dimensions of illustrated syntype length 20.2 mm, width 12.8 mm. Both specimens are very worn and faded with most of the spines and siphonal canal worn down. Both specimens were utilised for the drawing of the type-figure, which shows composite features of the aperture from the adult syntype and formation of the spines from the immature individual. Live-taken specimens always have well-extended spines, and only beach-rolled specimens show swollen, worn down knobs.

Genus **Spinidrupa** Habe and Kosuge, 1966

Spinidrupa Habe & Kosuge,1966, Venus:Jap.J.Malac. 24(4):315,330. Type species by OD *Murex eurantha* A.Adams = *M.euracanthus* A.Adams,1853. Recent, Indo-Pacific.

1966. *Spinidrupa* Habe & Kosuge, Shells world col. 2:54 *(nomen nudum).*



Figs. 22-26. *Muricopsis noduliferus* (Sowerby). 22, 23. Syntype BMNH No. 1842.5.10., 20.2 mm; Masbate I, Philippines. 24. Specimen from Viti Levu Bay, Viti Levu, Fiji Is; 24.0 mm. 25, 26. Specimen from Ogea I, Fiji Is, 27.0 mm.

Spinidrupa euracantha (A. Adams, 1853) (Figs. 27-30)

1845. *Murex noduliferus* "Sowerby",Reeve, Conch. Iconica 3:pl.31,fig.150 (*non* Sowerby, 1841).

1853. *Murex euracanthus* A.Adams,Proc.Zool.Soc.Lond. Pt.19:268 (*nom. subst.pro M.noduliferus* Reeve,1845).

1880. *Murex (Phyllonotus) euracanthus* A.Ad., Tryon,Man.Conch. 2:111,pl.30,fig.287.

1963. *Drupa(Morula)ambusta* (Dall),Shikama,Select.shells world col. 1:pl.59,fig.2 (*non Morula ambusta* Dall,1923).

1966. *Spindidrupa eurantha* (*sic*) (A.Adams), Habe & Kosuge, Shells world col. 2:54,pl.20, fig.4.

1972. *Muricopsis(Spinidrupa)eurantha* (*sic*), A.Adams,Ponder, J.Malac.Soc. Australia 2(3): 243.

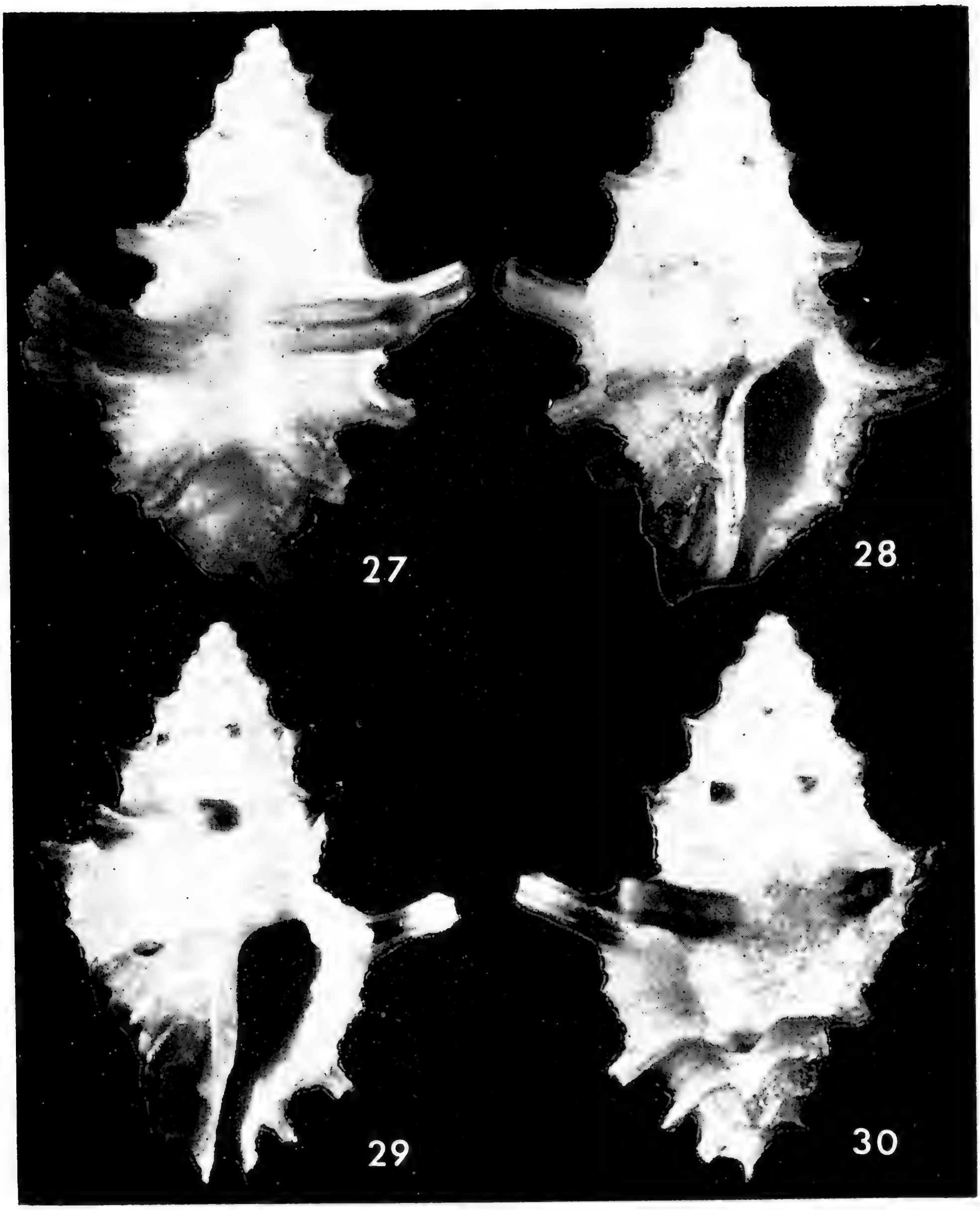
TYPE LOCALITY. None.

Tryon (1880) and Ponder (1972) suggested that *E.euracantha* could prove to be identical with *Muricopsis noduliferus* (Sowerby). The 4 syntypes of *Murex euracanthus* A. Adams (which are also the types of *M.noduliferus Reeve*) are in the Brit.Mus.(Nat.Hist.), London, No. 19763. One syntype is a small juvenile, two specimens, including the long-spined individual illustrated by Reeve (1845) are worn, and only one specimen shows a moderately crisp sculpture. These syntypes are quite different to *Muricopsis noduliferus* (Sowerby), and differ primarily in the prominent spiral sculpture. The anterior half of the spire whorls below the periphery of the spines, has 4-5 spiral cords, the presutural ramp is distinctly axially fimbriate, and the body whorl has 2-3 main spiral cords and 3-4 smaller, intermediate threads; spire whorls have a single row of spines and the body whorl has 4 rows, with the fourth row terminating at the siphonal fasciole. The development of the spines is extremely variable, and in the specimen illustrated by Reeve (*op.cit.*), the dorsal side of the body whorl carries 2 rows of excessively long spines (Figs. 27, 28).

The apertural features are more similar to *Cronia*: the columella descends almost vertically and has 2 weak basal folds, and the outer lip 5-6 denticles. The syntypes are worn, white in colour, with the spines and fasciolar region brown, and in one syntype the base of the columella and siphonal canal are stained with violet. The radula of *Spinidrupa euracantha* is unknown, and the species may prove to be closer to *Cronia* than to *Muricopsis*. *S.euracantha* is closely similar to the very variable *Morula spinosa* (H. & A. Adams, 1853) [= *Ricinula chrysostoma* Reeve, 1846 — *non* Deshayes, 1844, = *Murex iostomus* A. Adams, 1853 — *non* Sowerby, 1834, = *Sistrum andrewsi* E. A. Smith, 1909, = *Morula ambusta* Dall, 1923], and short-spined individuals of *S.euracantha* also resemble *Morula biconica* (Blainville, 1832). *Spinidrupa euracantha* has been illustrated under the name "*Drupa (Morula) ambusta* Dall" (which is actually a substitute name for *Ricinula chrysostoma* Reeve, 1846) by Shikama (1963). The original tablet on which the type-specimens of *Murex euracanthus* have been mounted bears a remark " = *iostoma* var.".

Genus **Cronia** H. & A. Adams, 1853

Cronia H. & A. Adams,1853, Gen.Rec.Moll. 1:128. Type species by M *Purpura amygdala* Kiener,1835. Recent, Indo-Pacific.



Figs. 27-30. *Spinidrupa euracantha* (A. Adams). Syntype of *Murex noduliferus* Reeve, and *M.euracanthus* A. Adams, BMNH No. 19763. 27, 28. Syntype, 22.6 mm 29,30. Syntype, 18.1 mm.

Cronia ochrostoma (Blainville, 1832) (Figs. 31-36)

1832. *Purpura ochrostoma* Blainville,Nouv.Ann.Mus.Hist.Nat. 1:205; 1835 Kiener,Spec.gen. icon.coq.viv. 8:44,pl.10,fig.29.

1833. *Pupura nassoides var.* Quoy & Gaimard, Voy.L'Astrolabe, Zool. 2:564, pl.38, figs. 10, 11 only (*non P.nassoidea* Blainville,1832.

1846. *Ricinula ochrostoma* Blainville, Reeve,Conch.Iconica 3:pl.4,fig.31.

1846. *Ricinula cavernosa* Reeve,Conch.Iconica 3:pl.4,figs.38a,b.

1880. *Ricinula(Sistrum)ochrostoma* (*pars*) Blainville, Tryon,Man.Conch. 2:187,pl.57,fig.230, and pl.58,fig.231 only.

1967. *Drupa(Drupella)ochrostoma* (Blainville),Maes-Orr, Proc.Acad.Nat.Sci. Philadelphia 119(4):130,pl.11,fig.1.

TYPE LOCALITIES. Tonga Is = error; should be New Ireland (*P.ochrostoma*); New Ireland (*P.nassoides*); Philippine Is (*R.cavernosa*).

DISTRIBUTION. Tropical Indo-Pacific.

Purpura ochrostoma Blainville, is usually assigned to the genus *Drupella* Thiele, 1925, a genus characterised by an unusual radula in which the lateral teeth are long, slender, and "crow-bar"-shaped (Cernohorsky, 1969). Recent examination of the radula of *C.ochrostoma* from Indonesia, shows that the species has a radula dentition of the *Cronia* group, which differs from that of *Morula* by the absence of small lateral denticles (Figs. 35, 36). *C.ochrostoma* is characterised by its squat, biconic shape, adpressed and prominently wavy sutures which lack nodules, 6 swollen and angulate axial ribs on the body whorl and 4 spiral rows of nodulose body whorl cords, and an orange aperture which in many specimens shows a dark brown spot on the outer lip wall. In the form *cavernosa* Reeve, syntypes in the Brit.Mus.(Nat.Hist),London, No. 1968469 (Figs. 33, 34), the spiral cords are more prominent and the body whorl has a central row of dark brown spots. The specimen illustrated by Cernohorsky (*op.cit.*) as "*Drupella ochrostoma*" is the orange-mouthed male colour-form of the highly variable *Drupella cornus* (Roeding, 1798). Radwin & D'Attilio (1972) recently proposed the new genus *Evokesia* for the West American species *Sistrum* (?*ochrostoma* var.) *rufonotatum* Carpenter, 1864. The tropical Pacific *C.ochrostoma* is very similar in shell characters to the West American *rufonotatum,* their radulas are basically the same, and neither differs in radula pattern to species of *Cronia* H. & A. Adams.

Subgenus **Ergalatax** Iredale, 1931

Ergalatax Iredale,1931,Rec.Aust.Mus. 18(4):231,233. Type species by OD *E.recurrens* Iredale, 1931 = *Buccinum contractum* Reeve. 1846. Recent, Indo-Pacific.

Cronia (Ergalatax) contracta (Reeve, 1846) (Figs. 37-41)

1846. *Buccinum contractum* Reeve,Conch.Iconica 3:pl.8,fig.53.

1846. *Buccinum funiculatum* Reeve,Conch.Inconica 3:pl.8,fig.61.

1860. *Murex calcarius* Dunker,Malak.Blaetter 6:230; 1861 Dunker,Moll. Japonica p.5,pl.1, fig.2.

1879. *Urosalpinx innotabilis* E.A.Smith,Proc.Zool.Soc.Lond. p.201,pl.20,fig.32.

1884. *Urosalpinx contracta* (Reeve),E.A.Smith,Rept.Zool.coll.H.M.S."Alert",p.47 (placed *U.innotabilis* in synonymy); 1901 Melville & Standen, Proc.Zool.Soc.Lond. 2:398.

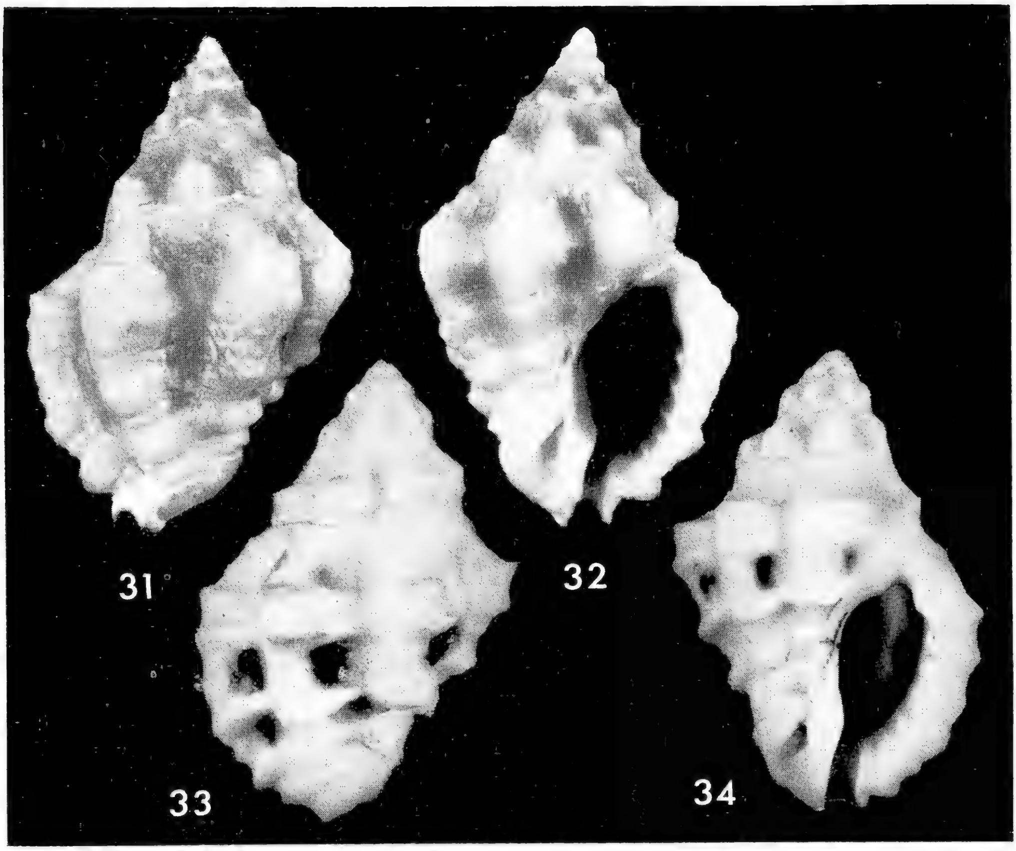
1893. *Coralliophila latiaxidea* Sowerby,Proc.Malac.Soc.Lond. 1:42,pl.4,fig.6.

1909. *Trophon contractus* Reeve,Hedley,Aust.Assoc.Adv.Sci.,sect.D, p.368.

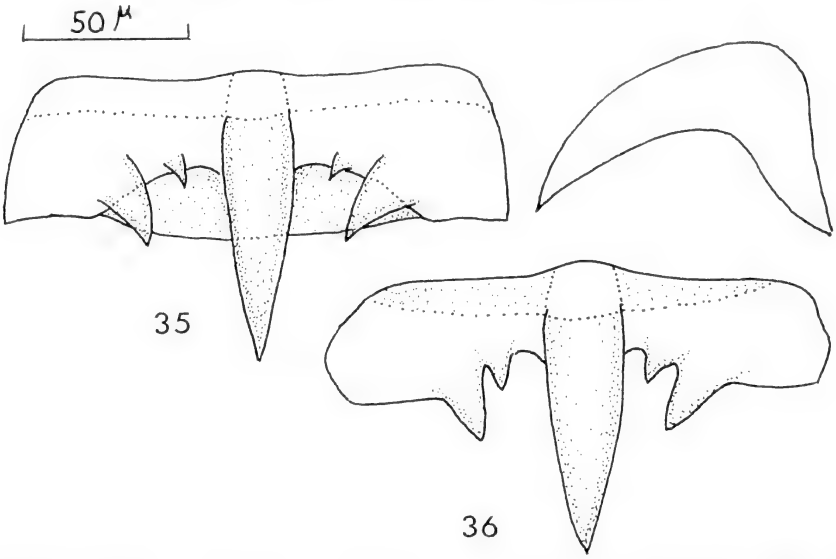
1918. *Xymene contracta* Reeve,Hedley,J.Proc.R.Soc.N.S.W. 51:M92.

1931. *Ergalatax recurrens* Iredale,Rec.Austral.Mus. 18(4):231.

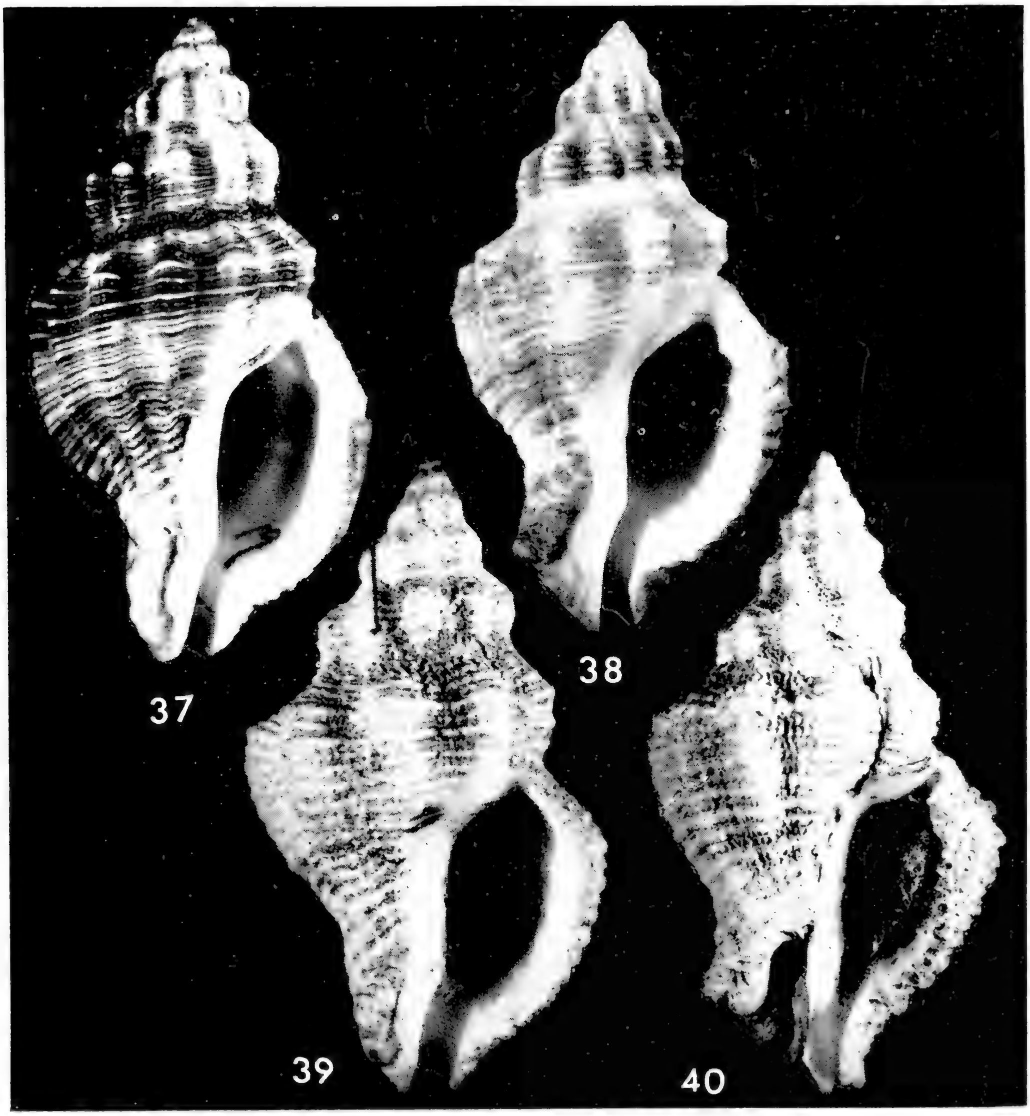
1957. *Tritonalia contracta* Reeve,Kaicher,Indo-Pacif.Sea shells,Muricacea-Buccinacea, pl.5, fig.6.



Figs. 31-34. *Cronia ochrostoma* (Blainville). 31, 32. Specimen from Rabaul, New Britain, 15.9 x 10.3 mm. 33, 34. Syntype of *Ricinula cavernosa* Reeve, BMNH No. 1968469, 15.0 x 10.4 mm; Burias I, Philippines.



Figs. 35, 36. *Cronia ochrostoma* (*Blainville*). 35. Half-row of radula (dorsal view). 36. Rhachidian tooth (ventral view).



Figs. 37-40. *Cronia* (*Ergalatax*) *contracta* (Reeve). 37. Syntype BMNH. 30.0 x 15.8 mm: Samar I, Philippines. 38. Specimen from Baié du Citron, New Caledonia; 26.0 x 15.0 mm. 39. Syntype of *Urosalpinx innotabilis* E. A. Smith, BMNH No. 1878.11.18.50. 19.4 x 10.8 mm; Nth. of Kiushiu, Japan. 40. Holotype of *Coralliophila latiaxidea* Sowerby, BMNH, 25.8 x 12.7 mm: Mauritius.

1959. *Urosalpinx heptagonalis* (Reeve,Barnard,Ann.Sth.Afric. Mus. 45:231,fig.40j (radula) [*non Ricinula heptagonalis* Reeve,1846].

1964. *Ergalatax constrictus* (*sic*) (Reeve),Habe, Shells west.Pacif.col. 2:84,pl.27,fig.11.

1964. *Ergalatax constrictus calcareus* (*sic*) (Dunker) Habe, *ibid.* 2:84,pl.27,fig.12.

1972. *Ergalatax contracta* (Reeve),Radwin, Veliger,15(1):36,fig.4 (shell), fig.5 (radula).

TYPE LOCALITIES. Samar I, Philippine Is (*B.contractum*); None (*B.funiculatum*); Japan (*M.calcarius*); Nth. of Kiushiu, Japan, 33°56′N & 130°27′E, 30 fathoms (55 m) (*U.innotabilis*); Mauritius (*C.latiaxidea*); Sydney Harbour, Australia (*E.recurrens*).

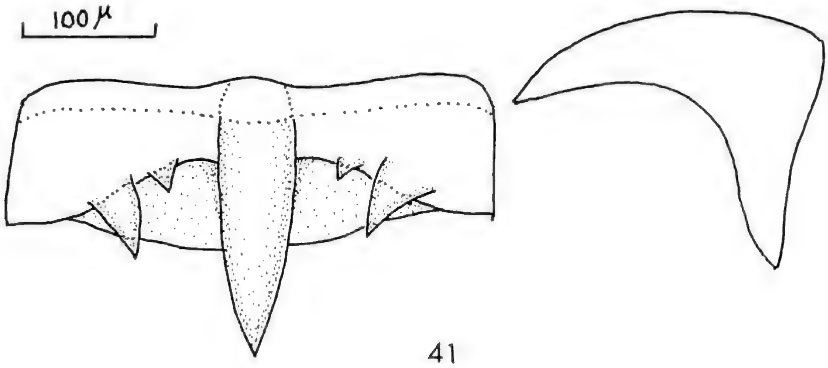


Fig. 41. *Cronia (Ergalatax) contracta* (Reeve). Half-row of radula.

C.(*E.*)*contracta* is usually assigned to the genus *Ergalatax* Iredale, however, the radula examined from a New Caledonian specimen (Fig. 41), agrees in all essential features with the radula of *Cronia* H. & A. Adams. The species is extremely variable in shape, sculpture, length of siphonal canal and colour, a fact recognised already by E. A. Smith (1884), when he synonymised his *Urosalpinx innotabilis* with *contracta* Reeve. *C.*(*E.*)*contracta* closely resembles *C.margariticola* (Broderip), and both species are frequently found mislabelled in Museum collections.

Murex calcarius Dunker, 1860, described from Japan, is the stumpy form of *C.*(*E.*)*contracta*. The syntypes of *Urosalpinx innotabilis* E. A. Smith, length of illustrated syntype 19.4 mm, width 10.8 mm, are in the Brit.Mus. (Nat.Hist.), London, No.1878.11.18.50. (Fig. 39), and these are also the broad form of C.(*E.*)*contracta*. The holotype of *Coralliophila latiaxidea* Sowerby, is in the same Institution, and measures 25.8 x 12.7 mm; the fasciolar callus is more exaggerated than in normal specimens (Fig. 40). Three syntypes of *Buccinum contractum* Reeve, are also in the Brit.Mus. (Nat.Hist.), dimension of illustrated syntype 30.0 x 15.8 mm (Fig. 37).

The usual colouring of C.(*E.*)*contracta* is cream, with narrow or broad brown transverse bands; some specimens, however, are uniformly cream, fawn, or pale brown. All specimens are spirally corded, but some individuals have more prominently imbricated spiral cords than others.

Family BUCCINIDAE Rafinesque, 1815

Genus **Phos** Montfort, 1810

Subgenus **Strongylocera** Moerch, 1852

Stronglocera Moerch,1852, Cat.Conchyl.Yoldi 1:80. Type species by SD (Cossman,1901) *Buccinum cancellatum* Quoy & Gaimard,1833 (*non* Gravenhorst,1807) = *B.textum* Gmelin,1791. Recent, Indo-Pacific.

Phos(Strongylocera)textilis (A. Adams, 1851) (Fig. 42)

1851. *Phos textilis* A.Adams,Proc.Zool.Soc.Lond. Pt.18:154; 1859 Sowerby, Thes.Conchyliorum 3:93,pl.222,fig.s.48,49.

1881. *Phos senticosus* (*pars*) Linnaeus, Tryon,Man.Conch. 3:216,pl.83,figs.492,493 only (*non Murex senticosus* Linnaeus,1758).

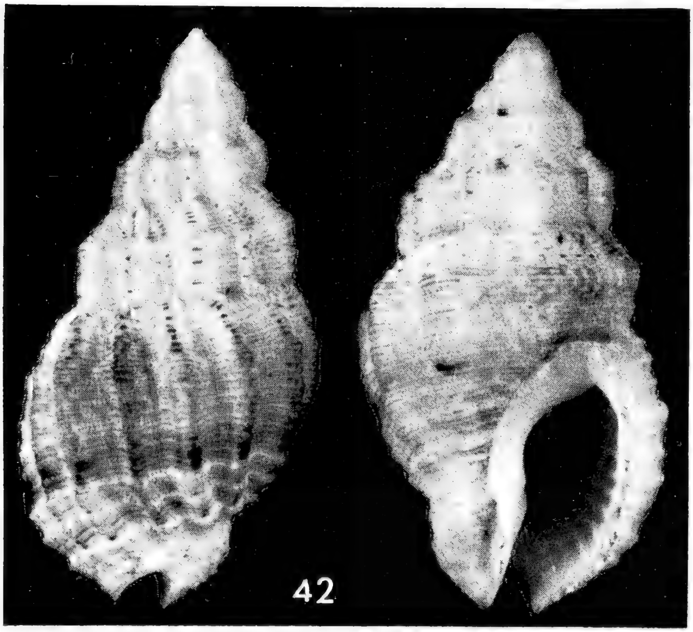


Fig. 42. *Phos* (*Strongylocera*) *textilis* A. Adams. Nordup, East New Britain, 24 m; 10.1 x 5.0 x 5.0 mm (dorsal view) and 11.0 x 6.1 x 5.7 mm (ventral view).

TYPE LOCALITY. Dumaguete, Philippine Is.

Shell about 11.0 mm in length, teleconch of 4 mature whorls which are angulate at the presutural ramp, protoconch of 4 smooth, creamy-white embryonic whorls, first 1-2 embryonic whorls nipple-like, last embryonic whorl large and swollen; sculptured with angulate axial ribs which become nodose on the presutural ramp and number from 10-11 on the penultimate and from 8-15 on the body whorl. Numerous spiral threads encircle the shell and number from 15-17 on the penultimate and from 22-30 on the body whorl, 3 spiral cords elevated and prominent on anterior half of body whorl. Outer lip variced, interior of aperture lirate, parietal wall minutely wrinkled, anterior of columella with 2 folds, siphonal fasciole calloused and corded. White in colour, finely peppered with small brown spots, axial ribs finely lined with brown, anterior third of body whorl sometimes with a faint, interrupted brown band, aperture white.

The species has been originally inadequately described, and no recent specimens have been reported or illustrated. The species has been collected in deep water off Nordup, New Britain, by Mr B. Parkinson.

Family NASSARIIDAE Iredale, 1916

(The validity of the family name is currently under consideration by the I.C.Z.N.)

Genus **Nassarius** Duméril, 1806

Nassarius Duméril,1806, Zool.Analyt. p.166. Type species by SM (Froriep,1806) *Buccinum arcularia L.* = *B.arcularia* Linnaeus,1758. Recent, Indo-Pacific.

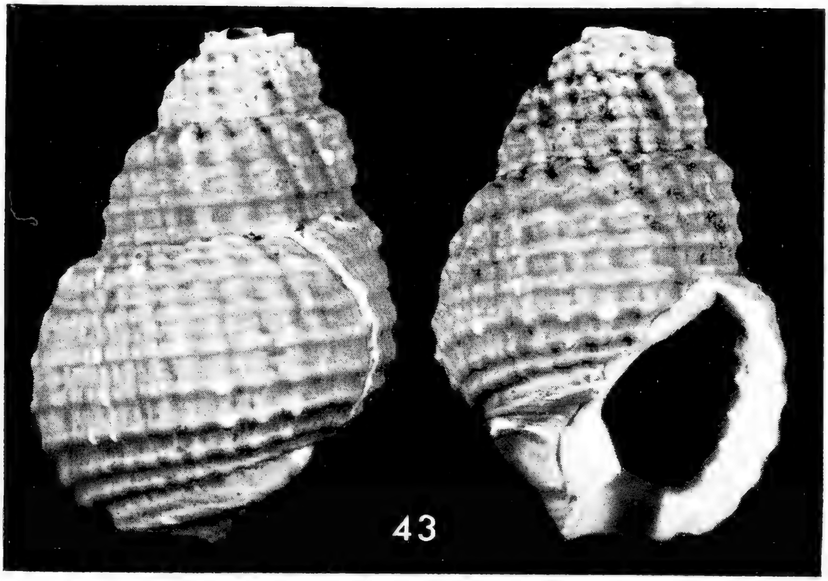


Fig. 43. *Nassarius coppingeri* (E. A. Smith). Gulf of Panama, 520 m; 16.8 + 12.0 x 10.6 mm (protoconch missing).

Nassarius coppingeri (E.A.Smith,1881) (Fig.43)

1881. *Nassa(Tritia) coppingeri* E.A. Smith, Proc.Zool.Soc.Lond.p.30,pl.4,fig.7; 1882 Tryon, Man.Conch. 4:56,pl.18,fig.372; ? 1951 Carcelles & Williamson, Rev.Inst.Nac.Inv.Cienc. Nat. 2(5):299.

1908. *Alectrion(Hima)miser* Dall,Bull.Mus.Comp.Zool.Harvard 43(6):307,pl.4,fig.1.

1917. *Alectrion miser Dall,* Proc.U.S.Nat.Mus. 51:576.

1958. *Nassarius miser* (Dall), Keen,Seashells trop.west America ed.1:410; 1971 Keen, *ibid.*, ed.2:607,fig.1306; 1974 Abbott, American Seashells ed.2:225.

1975. *Nassarius coppingeri* (E.A.Smith),Cernohorsky,Rec.Auckland Inst.Mus. 12:143,fig.50 (figd. holotype).

TYPE LOCALITIES. Tom Bay, near Madre de Dios Archipelago, Southern Chile, 1-30 fathoms (2-55 m) (*N.coppingeri*); St.3355, Gulf of Panama, 7°12′20″N & 80°55′W, in 182 fathoms (333 m), at 46° to 56.2°F (7.8° — 13.5°C), mud (*A.miser*).

DISTRIBUTION. From Baja California to Panama and Southern Chile, from 55-590 m.

Cernohorsky (1975) illustrated the holotype of the Chilean *N.coppingeri* (E. A. Smith), and remarked on the close similarity between this species and the Panamanian *N.miser* (Dall). Recent examinations of a series of specimens of *N.miser* from the Gulf of Panama, 7°28′N and 79°36′W, in 520 m, green mud (Mortensen Exped., Zool. Mus. Copenhagen), leave no doubt that the two species are indeed conspecific. The rope-like spiral cords and very broad siphonal canal are characteristic of the species. The colour varies from straw-yellow to brown and the protoconch is usually eroded. The similarity of *N.coppingeri* to the Austral-Neozelanic deep water *N.(Cryptonassarius)ephamillus* (Watson, 1882) is rather striking, except that *N.ephamillus* lacks the well-formed denticles on the outer lip.

Acknowledgements. I would like to express my thanks to Dr. H. A. Rehder, U.S. National Museum, Smithsonian Institution, Washington, for making preserved specimens of *C.ochrostoma* (Blainville), available for examination, and for expressing his doubts as to the species *Drupella* affinities; to Dr J. Taylor and Ms K. Way, British Museum (Nat.Hist.), London, for allowing me access to the type-collections and for the loan of type-specimens; to Ms E. Wright, Sanibel I, Florida, for the loan of specimens of *Muricopsis orri* sp.n.; to Dr. J. Knudsen, University Zoological Museum, Copenhagen, for specimens of *N.miser* and to Mr. B. Parkinson, Rabaul, New Britain, for dredged specimens of *Phos textilis.*

REFERENCES

CERNOHORSKY, W. O.

1969 The Muricidae of Fiji. Part II — Subfamily Thaidinae. *Veliger* 11(4):293-315, pl. 47-49, textfigs.

1975 The taxonomy of some West American and Atlantic Nassariidae based on their type-specimens. *Rec. Auckland Inst. Mus.* 12:121-173, 93 text figs.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

1970 Declaration 43 — Repeal of Article 23(b). *Bull. zool. Nomencl.* 27(3/4):135-162.

PONDER, W. F.

1972 Notes on some Australian genera and species of the family Muricidae (Neogastropoda). *J. Malac. Soc. Aust.* 2(3): 215-248, pl. 20-23, 36 textfigs.

RADWIN, G. E. and A. D'ATTILIO

1972 The systematics of some new world muricid species (Mollusca, Gastropoda), with descriptions of two new genera and two new species. *Proc.Biol. Soc. Washington* 85 (28) : 323-352, 26 textfigs.

REEVE, L.

1845-46 *Conchologia Iconica; monograph of the genus Murex.* London, L. Reeve, 3: pl. 1-36, Supply. pl.1.

SHIKAMA, T.

1963 *Selected shells of the world illustrated in colours.* Tokyo, Hokuryu-Kan Publ. Co. Ltd. 1:154, pl. 1-102, textfigs.

SMITH, E. A.

1884 *Report on the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "Alert"* 1881-2. London, pp. 1-684, pl. 1-54.

TRYON, G. W.

1880 *Manual of Conchology; structural and systematic.* Philadelphia, G. W. Tryon, 2:1-289, pl. 1-70.

VOKES, E. H.

1971 Catalogue of the genus *Murex* Linné (Mollusca: Gastropoda); Muricinae, Ocenebrinae. *Bull. Am. Paleont.* 61 (268): 1-141.

NOTES ON THE TAXONOMY OF INDO-PACIFIC TEREBRIDAE (MOLLUSCA: GASTROPODA), WITH DESCRIPTION OF A NEW SPECIES

W. O. CERNOHORSKY* AND T. BRATCHER**

*AUCKLAND INSTITUTE AND MUSEUM

**HOLLYWOOD, CALIFORNIA, U.S.A.

Abstract. A species of Terebridae from the Indo-West Pacific is described as new and a substitute name is proposed for the homonymous *Terebra monile* Quoy & Gaimard. *T.albomarginata* Deshayes, *T.archimedis* Deshayes, *T.pallida* Deshayes and *T.lauta* Pease, are now considered to be synonyms of previously described species.

Recent visits to Museums in London and Paris and examination of type-specimens of Terebridae in these Institutions, have greatly assisted in the elucidation of the identity of previously obscure species of Terebridae. Although much work remains to be accomplished on the range of variability in Terebridae species, sufficient evidence is available in species where larger series of specimens are available. Consequently, taxa previously considered to be valid biospecies will disappear in synonymy of chronologically prior species-names.

Family TEREBRIDAE Moerch, 1852

1852. Terebrina Moerch, Cat. Conchyl. Yoldi 1 : 74.

1853. Acusidae Gray, Ann. Mag. Nat. Hist. ser. 2, 11 (62) : 129 (based on *Acus* Gray, 1847 — *non* Lacepède, 1803).

1853. Terebrinae H. & A. Adams, Gen. Rec. Moll. 1:224.

1969. Pervicaciidae Rudman, Veliger 12 (1) : 63.

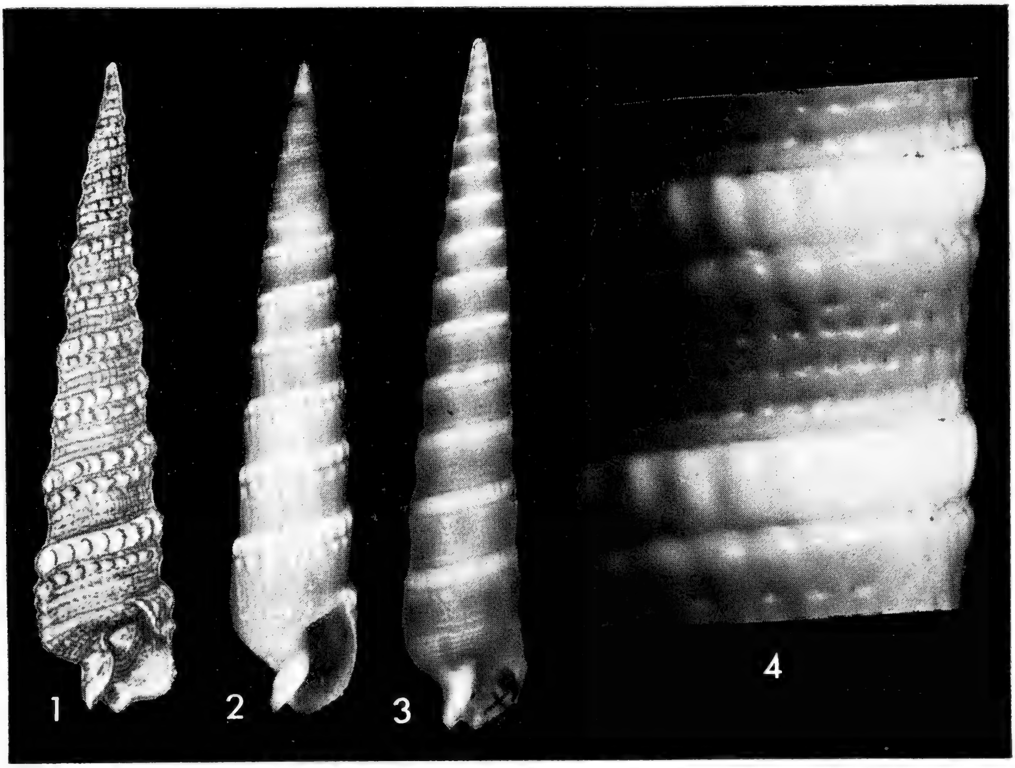
Genus **Terebra** Bruguière, 1789

Terebra Bruguière, Encycl. Méth. Hist. Nat. Vers. 1 : xv. Type species by SM (Lamarck, 1799) *Buccinum subulatum* Linnaeus, 1767. Recent, Indo-Pacific.

Terebra amanda Hinds, 1844 (Figs. 1-4)

1844. *Terebra amanda* Hinds, Proc. Zool. Soc. Lond. Pt. 11 : 154; 1844 Hinds in Sowerby, Thes. Conchyl. 1 : 166, pl. 45, fig. 100; 1859 Deshayes, Proc. Zool. Soc. Lond. Pt. 27: 315; 1860 Reeve, Conch. Icon. 12 : page facing pl. 1; 1885 Tryon, Man. Conch. 7 : 30, pl. 9, fig. 61; 1967 Cernohorsky, Mar. shells Pacific 1 : 196, pl. 49, fig. 351; 1972 Hinton, Shells New Guinea p. 46, pl. 23, fig. 21.

1859. *Terebra albomarginata* Deshayes, Proc. Zool. Soc. Lond. Pt. 27 : 314; 1860 Reeve, Conch. Icon. 12 : pl. 15, fig. 65; 1885 Tryon, Man. Conch. 7 : 29, pl. 9, fig. 54; 1944 Tomlin, J. Conch. 22 (5) : 107; 1969 Cernohorsky, Veliger, 11 (3) : 211; 1975 Coleman, What Shell is That, p. 236, fig. 657.



Figs. 1-4. *Terebra amanda* Hinds. 1. Lectotype figure (from Hinds in Sowerby, 1844, pl. 45, fig. 100). 2. Specimen from Natadola, Fiji Is; length 40.0 mm. 3,4. Holotype of *T.albomarginata* Deshayes, BMNH, 44.5 x 7.8 mm.

1966. *Terebra* (*Perirhore*) *amanda* Hinds, Cernohorsky & Jennings, Veliger, 9 (1) : 49, pl. 5, fig. 17.

1967. *Terebra* (*Dimidacus*) *amanda* Hinds, Bratcher & Burch, Veliger, 10 (1) : 9.

1967. *Terebra* (*Dimidacus*) *albomarginata* Deshayes, Bratcher & Burch, Veliger, 10 (1) : 9.

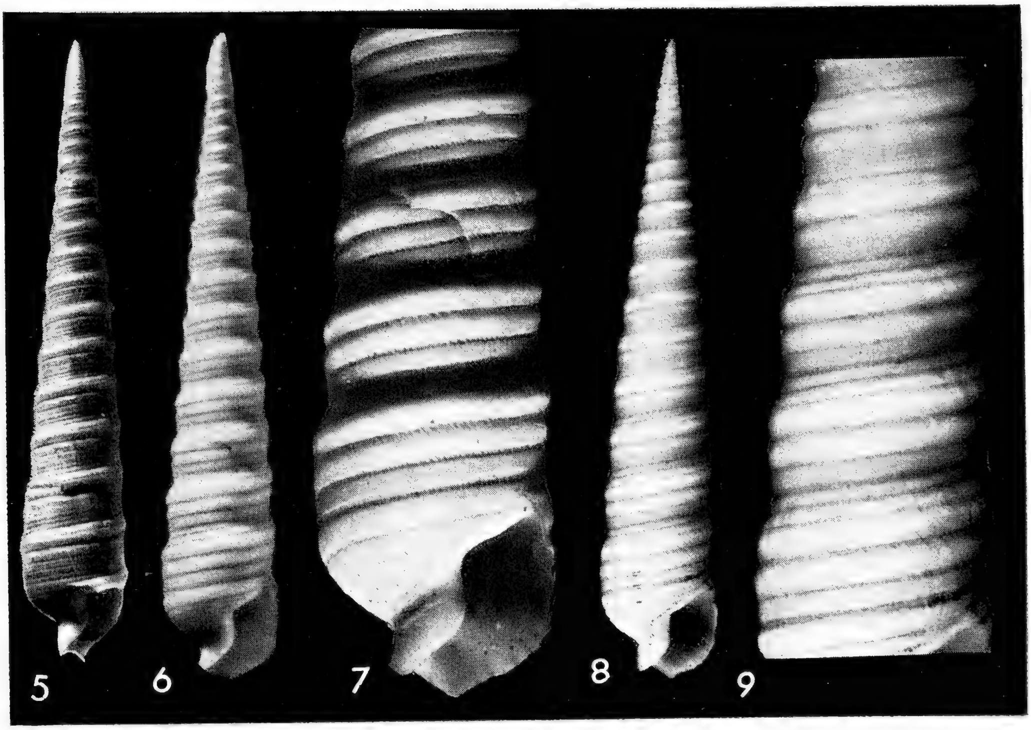
1967. *Dimidacus stamineus* (*sic*) Gray, Habe & Kosuge, Stand. book Jap. shell col. 3 : 102, pl. 40, fig. 19 (*non Terebra straminea* Gray, 1834).

TYPE LOCALITY. Straits of Macassar, Indonesia, 11 fathoms (20 m) (*T.amanda*); Australia (*T.albomarginata*).

Type specimens. The type of *T.amanda* Hinds, is lost. The holotype of *T.albomarginata* Deshayes, length 44.5 mm, width 7.8 mm (Fig. 3, 4), is in the British Museum (Nat. Hist.), London.

DISTRIBUTION. Red Sea to the Hawaiian Is.

The type of *T.amanda* Hinds, has been reported lost as early as 1860 by Reeve (1860), and several searches in the British Museum (Nat. Hist.), London, for the type proved fruitless. Hinds' original description and well-executed illustration of the missing type (Fig. 1) show all the salient points of the species and *T.albomarginata* is without doubt conspecific with



Figs. 5-9. *Terebra funiculata* Hinds. 5. Syntype BMNH, length 50.3 mm. 6, 7. Holotype of *T.archimedis* Deshayes, École de Mines, Paris; length 31.0 mm. 8, 9. Specimen from Lomalagi, Fiji, Is; length 40.5 mm.

T.amanda. The species is characterised by a double-row of sutural nodules and the punctate spiral grooves. It is very variable in colour, ranging from yellow to orange and orange-brown.

Hinds' type figure (Hinds in Sowerby, 1844, pl. 45, fig. 100) is here designated as the lectotype of *T.amanda* (Fig. 1).

Terebra funiculata Hinds, 1844 (Figs. 5-9)

1844. *Terebra funiculata* Hinds, Proc. Zool. Soc. Lond. Pt. 11 : 153; 1844 Hinds in Sowerby, Thes Conchyl. 1 : pl. 43, fig. 63; 1859 Deshayes, Proc. Zool. Soc. Lond. Pt. 27 : 312; 1860 Reeve, Conch. Icon. 12 : pl. 12, fig. 48; 1885 Tryon, Man. Conch. 7 : 19, pl. 9, fig. 60; 1937 Viader, Mauritius Inst. Bull. 1 (2) : 5; 1952 Tinker, Pacific Sea shells, p. 22, facing pl., figs. upper row, centre; 1960 Weaver, Hawaiian Mar. Moll. 1 (2) : 6, pl. 2, fig. bottom left; 1967 Cernohorsky, Mar. shells Pacific 1 : 200, pl. 50, fig. 369; 1967 Kay, Hawaiian Shell News 15 (7) : 1, 2 figs. on right; 1969 Cernohorsky, Veliger 11 (3) : 215.

1859. *Terebra archimedis* Deshayes, Proc. Zool. Soc. Lond. Pt. 27 : 314; 1860 Reeve, Conch. Icon. 12 : pl. 12, fig. 48 (in synonymy of *T.funiculata* Hinds); 1944 Tomlin, J. Conch. 11 (5) : 107; 1967, Kay, Hawaiian Shell News 15 (7) : 1, 2 figs. on left; 1972 Hinton, Shells New Guinea p. 46, pl. 23, fig. 17.

1921. *Terebra langfordi* Pilsbry, Proc. Acad. Nat. Sci. Philadelphia 72 : 304, pl. 12, fig. 6.

1921. *Terebra langfordi angustior* Pilsbry, Proc. Acad. Nat. Sci. Philadelphia 72 : 304, pl. 12, fig. 6.

1966. *Terebra* (Perirhoe) *funiculata* Hinds, Cernohorsky & Jennings, Veliger 9 (1) : 51, pl. 5, fig. 22.

1966. *Terebra* (*Perirhoe*) *langfordi* Pilsbry, Cernohorsky & Jennings, Veliger 9 (1) : 51, pl. 5, fig. 23.

TYPE LOCALITY. None (*T.funiculata* and *T.archimedis*); off Honolulu, Hawaiian Is, 6-8 fathoms (11-15 m) (*T.langfordi*); Honolulu dredger dump (*T.langfordi angustior*).

Type specimens. Two syntypes of *T.funiculata* Hinds, length 50.3 mm and 46.5 mm (Fig. 5) are in the British Museum (Nat. Hist.), London. The holotype of *T.archimedis* Deshayes, length 31.0 mm, width 5.8 mm (Fig. 6, 7) is in the École de Mines, Paris. The types of *T.langfordi* Pilsbry, given size 41.0 x 7.8 mm and 50.0 x 9.0 mm, and of *T.langfordi angustior* Pilsbry, given size 29.0 x 5.0 mm, are in the Academy of Natural Sciences, Philadelphia.

DISTRIBUTION. Mauritius to South Africa, Japan and the Hawaiian Is, 0 - 183 m.

T.funiculata is an extremely variable species and intergrades between all sculptural forms are found. In the main forms of this species, the spiral sculpture consists of either a double or triple sutural band which is followed by 2-3 convex cords, or 3 flat cords or 6 shallow, axially striate grooves; in some individuals the sutural bands are followed by indistinct cords and curved axial growth-striae.

Terebra punctatostriata Gray, 1834 (Figs. 10-13)

1834. *Terebra punctatostriata* Gray, Proc. Zool. Soc. Lond. Pt. 2 : 61; 1844 Hinds, Proc. Zool. Soc. Lond. Pt. 11 : 163 (in synonymy of *T.cingulifera* Lamarck, 1822); 1859 Deshayes, Proc. Zool. Soc. Lond. Pt. 27 : 320; 1969 Cernohorsky, Veliger 11(3) : 218.

1857. *Terebra pallida* Deshayes, J. Conchyl. 6 : 87, pl. 4, fig. 3; 1859 Deshayes, Proc. Zool. Soc. Lond. Pt. 27 : 311; 1944 Tomlin, J. Conch. 22 (5) : 107; 1967 Cernohorsky, Marine Shells Pacific 1 : 205, pl. 51, fig. 382; 1969 Cernohorsky, Veliger 11 (3) : 218; 1972 Hinton, Shells New Guinea p. 48, pl. 24, fig. 19.

1860. *Terebra cingulifera* Lamarck (*pars*), Reeve, Conch. Icon. 12 : pl. 11, fig. 44a only; 1885 Tryon, Man. Conch. 7 : 27 pl. 8, fig. 36 only (*non* Lamarck, 1822).

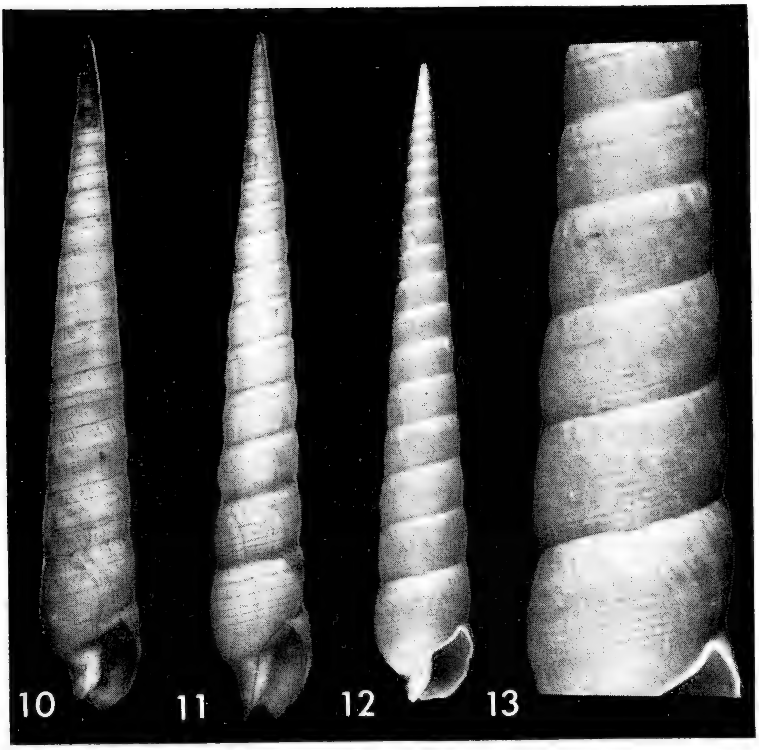
1931. *Perirhoe exulta* Iredale, Rec. Austral. Mus. 18 : 224, pl. 25, fig. 3.

1966. *Terebra* (*Perirhoe*) *pallida* Deshayes, Cernohorsky & Jennings, Veliger, 9 (1) : 52, pl. 5, fig. 19.

1967. *Dimidacus cinguliferus* (Lamarck), Habe & Kosuge, Stand. book Jap. shell col. 3 : 102, pl. 40, fig. 15 (*non Terebra cingulifera* Lamarck, 1822).

TYPE LOCALITY. None (*T.punctatostriata*); Marquesas Is (*T.pallida*); Sydney Harbour, Australia (*P.exulta*).

Type specimens. The holotype of *T.punctatostriata* Gray, is in the British Museum. (Nat. Hist.), London, length 70.2 mm (Fig. 10). Three syntypes of *T.pallida* Deshayes, are in the same Institution, length of designated lectotype 71.8 mm. The type of *Perirhoe exulta* Iredale, is in the Australian Museum, Sydney.



Figs. 10-13. *Terebra punctatostriata* Gray. 10. Holotype BMNH No. 74. 11. 10. 1.; length 70.2 mm. 11. Lectotype of *T.pallida* Deshayes, BMNH; length 71.8 mm. 12 13. Specimen from Natadola, Fiji Is; length 98.0 mm.

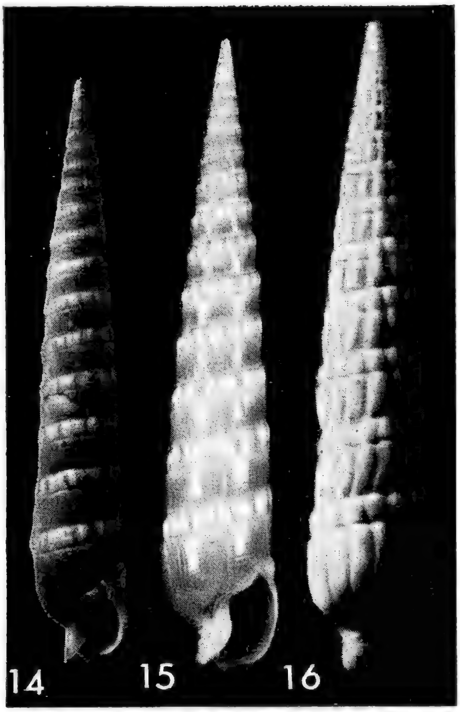
DISTRIBUTION. Tropical Pacific.

T.punctatostriata Gray, is not conspecific with *T.cingulifera* Lamarck, 1822, as assumed by some authors, but is an earlier name for *T.pallida* Deshayes. There is a resemblance to *T.cingulifera,* but in this species the whorls are almost straight-sided or even slightly concave and turreted with an obvious sutural band visible in profile, and the spiral grooves are prominently punctuate. The whorls of *T.punctatostriata* are convex and slightly inflated, the sutural band is weakly developed and not visible in profile, and the colouring is usually more reddish-orange or reddish-brown than in *T.cingulifera.*

T.pallida is a composite species. The two smaller syntypes, length 59.2 mm and 51.9 mm, are examples of *T.cingulifera* Lamarck, and only the largest, 70.2 mm long syntype is conspecific with *T.punctatostriata* Gray. We therefore designate the largest, 71.8 mm syntype as the lectotype of *T.pallida* Deshayes (Fig. 11).

Terebra quoygaimardi nom. n. (Figs. 14-15)

1833. *Terebra monile* Quoy & Gaimard, Voy. L'Astrolabe, Zool. 2 : 467, pl. 36, figs. 21, 22; 1838 Kuester, Syst. Conch. Cab. ed. 2, 5 (2) : 29, pl. 6, fig. 10 (*non Buccinum monile* Linnaeus, 1771 = *Terebra*).



Figs. 14-16. 14,15 *Terebra quoygaimardi nom.n.* 14. Holoype of *T.monile* Quoy & Gaimard, Mus. Nat. d'Hist. Nat., Paris; length 43.8 mm. 15. Specimen from Pearl reef, Great Barrier reef, Qld., Australia; length 37.8 mm. 16. *T.monile* (Linnaeus), probable holotype, Linn. Soc. Lond.; length 36.7 mm.

1844. *Terebra monilis* Quoy & Gaimard, Hinds, Proc. Zool. Soc. Lond. Pt. 11 : 163; 1844 Hinds in Sowerby, Thes. Conchyl 1 : 168, pl. 43, figs. 65, 66; 1844 Deshayes & Edwards, His. nat. anim. s. vert. ed. 2, 10 : 258; 1859 Deshayes, Proc. Zool. Soc. Lond. Pt. 27 : 312; 1860 Reeve, Conch. Icon. 12 : pl. 11, fig. 42a; 1885 Tryon, Man. Conch. 7 : 28, pl. 8, figs. 47, 48 (in synonymy of *T.straminea* Gray); 1967 Cernohorsky, Marine shells Pacific 1 : 204, pl. 51, fig. 377.

1964. *Terebra* (*Cinguloterebra*) *monilis* Quoy & Gaimard, Shikama, Select. Shells world col. 2 : pl. 69, fig. 19.

1966. *Cinguloterebra monilis* (Quoy & Gaimard), Habe & Kosuge, Shells world col. 2 : 99, pl. 39, fig. 14.

1967. *Dimidacus monilis* (Quoy & Gaimard), Habe & Kosuge, Stand. book. Jap. shells col. 3 : 102, pl. 40, fig. 17.

TYPE LOCALITY. Marianas and Caroline Is.

Type specimens. The holotype of *T.monile* Quoy & Gaimard (= *T.quoygaimardi* nom.n.), is in the Muséum National d'Histoire Naturelle, Paris, length 43.8 mm, width 6.9 mm (Fig. 14); one paratype measures 41.2 x 6.7 mm.

DISTRIBUTION. Andaman Is to Mauritius, Nth. Australia, Micronesia and Japan.

Dodge (1956), who treated Linnaeus' *Buccinum* species in detail, and several authors before him, concluded that *Buccinum monile* Linnaeus, 1771, is a *Terebra* of unknown identity. A specimen in the Linnaean collection of the Linnaean

Society, London, contains a *Terebra* species 36.7 mm in length and 7.2 mm in width, which appears to be a very faded *T.undulata* Gray, 1934 (Fig. 16). This particular specimen is undocumented and has been segregated by Hanley from an unmarked box. Since the origin of this probable type-specimen is unknown, it is better to consider *T.monile* (Linnaeus) as a *nomen dubium,* and retain *T.undulata* Gray in malacological literature. Since *Terebra monile* Quoy & Gaimard, 1833, is a secondary homonym of *Buccinum monile* Linnaeus, 1771, it is here replaced with *T.quoygaimardi.*

Terebra parkinsoni sp. n. (Figs. 17-21)

Shell moderately small, up to 30.0 mm in length, slender and shining, teleoconch of $14\frac{3}{4}$-16 mature, weakly convex whorls, protoconch multispiral, consisting of $3\frac{1}{2}$-$3\frac{3}{4}$ smooth, glassy, conoidal embryonic whorls which are separated from each other by a narrow sutural band; early whorls sculptured with fine, sharp and slightly curved axial ribs, later whorls with broad, roundly angulate axial ribs which are straight at the sutures and then become arcuate; axial ribs number from 13-16 on the penultimate and from 14-17 on the body whorl, ribs broadening from summit towards interspaces, sutural band only weakly indented and obsoletely indicated by single pits in interspaces, remaining spiral sculpture consisting of short, flat grooves which do not ascend the walls of the axial ribs; spiral grooves number from 6-10 on the penultimate and from 10-19 on the body whorl. Axial ribs cease at the anterior third of the body whorl and are then followed by 5-6 fine spiral threads, siphonal fasciole with up to 10 macrostriae. Outer lip thin and convex, columella without a callus and with a simple basal fold, siphonal fasciole with an elevated, oblique cord, siphonal notch distinct. Base colour shining white, cream or pale beige, ornamented with dark orange-brown between most of the axial ribs on the last six whorls.

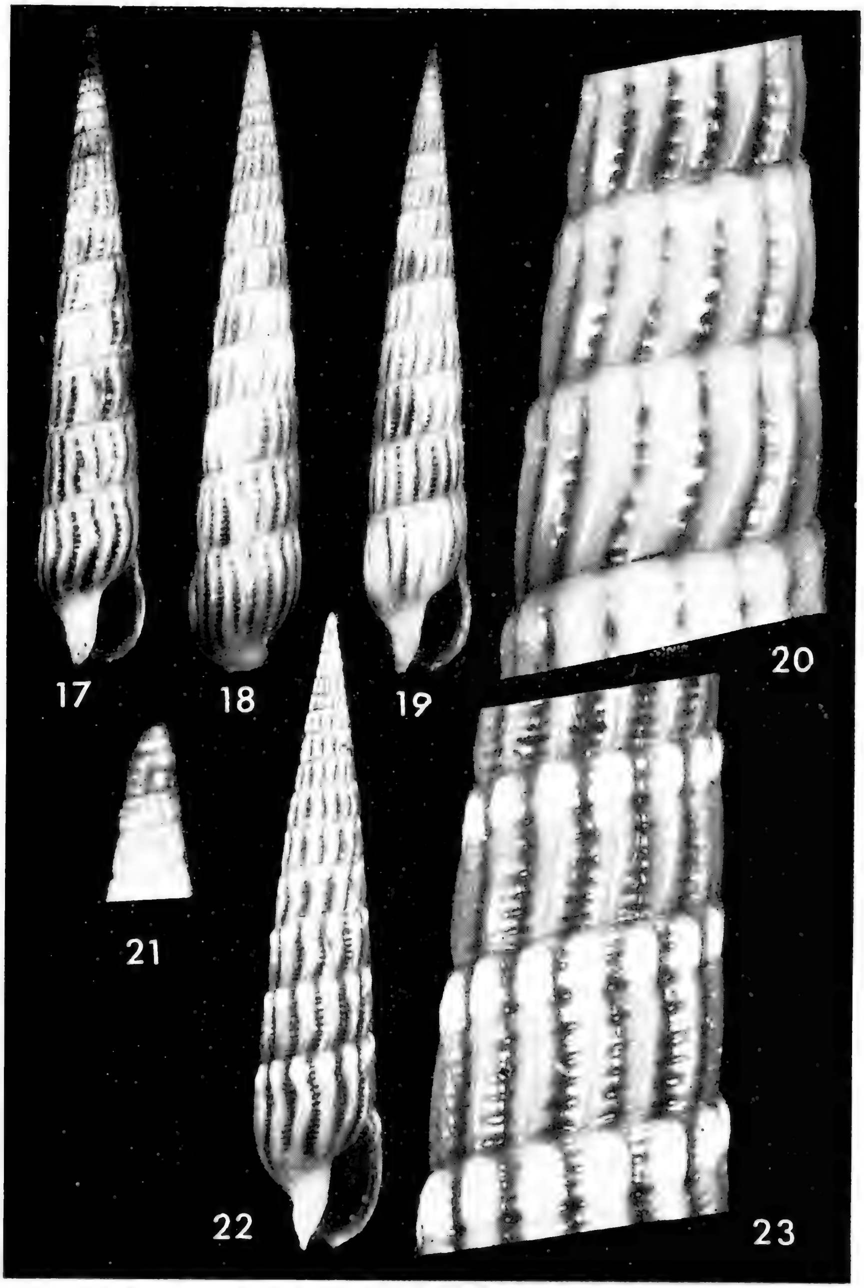
TYPE LOCALITY. Nordup, East New Britain, 24 metres.

DISTRIBUTION. From New Britain to the Red Sea.

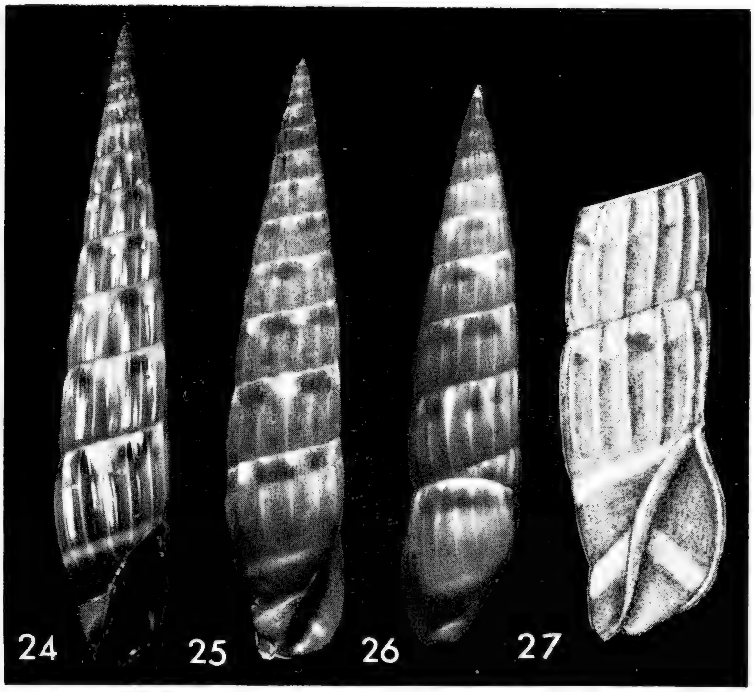
Holotype. Auckland Institute and Museum No. TM-1347; length 29.4 mm, width 5.2 mm (Figs. 17, 18).

Paratypes. Several paratypes from New Britain in the National Museum of Nat. History, Washington; Delaware Museum of Nat. Hist; coll. B. Parkinson, Rabaul; coll. H. Eker, Sanibel, and the authors' collection; two paratypes from Ras Andadda, Ethiopia, and from the Dahlak Archipelago, Red Sea, in the Hebrew University of Jerusalem, and one paratype from New Guinea in coll. O. K. McCausland.

In some individuals of *T.parkinsoni* all the interspaces of the axial ribs are coloured with orange-brown of varying strength with the exception of the first 7-8 post-embryonic whorls, while others have large areas devoid of this colouring. The closest relative of *T.parkinsoni* is *T.undulata* Gray, 1834 (Figs. 22, 23), but this species differs in the following characters: it is broader (*T.parkinsoni* 17% - 19% width of length, *T.undulata* 20% - 24%), the prominent sutural nodules give the shell a turreted appearance, axial ribs are straighter, the interstices are broader and of about the same width right up to the sutural band, whereas in *T.parkinsoni* the axial ribs are almost fused together at the posterior end of the sutural band, the spiral sculpture is crisper in *T.undulata,* with deeper and longer



Figs. 17-23. 17-21. *Terebra parkinsoni sp.n.* Nordup, E. New Britain. 17,18. Holotype AIM No. TM-1347; length 29.4 mm, width 5.2 mm. 19. Paratype 28.6 x 4.9 mm. 20. Sculptural detail of mid-whorls. 21. Protoconch. 22,23 *T.undulata* Gray; Nordup, E. New Britain, 28.6 x 6.0 mm.



Figs. 24-27. *Hastula matheroniana* (Deshayes). 24. Specimen from Teuma Bay, Efate I, New Hebrides, 37 - 46 m; length 24.0 mm. 25,26. Holotype of *H.matheroniana* (Deshayes), École de Mines, Paris; 18.0 mm. x 3.0 mm. Type-figure of *H.strigilata sumatrana* (Thiele); 25.0 x 4.0 mm (from Thiele, 1925, pl. 29, fig. 20).

spiral grooves which ascend the walls of the axial ribs without reaching the summit. The colouring of *T.undulata* is very constant throughout in a large series of specimens: the base colour is tan to orange-brown, the interspaces are regularly ornamented with dark brown and the distinct sutural nodules are white.

The species is named for Mr Brian Parkinson, Rabaul, New Britain, who collected several specimens of the new species in New Britain.

Genus **Hastula** H. & A. Adams, 1853

Hastula H. & H. Adams, 1853, Gen. Rec. Moll. 1 : 225. Type species by SD (Cossmann, 1896) *Buccinum strigilatum* Linnaeus, 1758. Recent, Indo-Pacific.

Hastula matheroniana (Deshayes, 1859) (Figs. 24-27)

1859. *Terebra matheroniana* Deshayes, Proc. Zool. Soc. Lond. Pt. 27 : 287; 1880 v. Martens, Beittr. Meeresf. Mauritius & Seychellen, p. 230; 1935 Dautzenberg, Mém. Mus. Roy. d'Hist. Nat. Belg. 2 (17) : 37; 1944 Tomlin, J. Conch. 22 (5) : 105.

1869. *Terebra lauta* Pease, Americ. J. Conch. 5 (1) : 66; 1885 Tryon, Man. Conch. 7 : 33, pl. 10, fig. 91 (figd. type specimen); 1952 Tinker, Pacif. Sea shells p. 16, facing pl., figs. bottom row right and left).

1925. *Terebra strigilata sumatrana* Thiele, Wiss. Ergeb. Deut. Tief. Exped. "Valdivia" 17 : 344, pl. 29, fig. 20.

1960. *Hastula lauta* (Pease), Weaver, Hawaiian Mar. Moll. 1(8) : 30, pl. 8, fig. top right; 1966 Cernohorsky & Jennings, Veliger, 9 (1) : 60/41 pl.7, fig. 51; 1967 Cernohorsky, Mar. shells Pacific 1 : 210, pl. 54, fig. 404.

TYPE LOCALITY. Tahiti, Society Is (*T.matheroniana*); Oahu, Hawaiian Is (*T.lauta*); Padang, Sumatra, Indonesia (*T.strigilata sumatrana*).

Type specimens. The holotype of *T.matheroniana* Deshayes, is in the École de Mines, Paris, dimensions 18.0 x 3.0 mm (Figs. 25, 26). The location of the type of *T.lauta* Pease, has not been traced; the given dimensions are 26.0 x 6.0 mm. The type of *T.strigilata sumatrana* Thiele is in the Humboldt University Zoological Museum, Berlin, given dimensions 25.0 x 4.0 mm (Thiele 1925) (Fig. 27).

DISTRIBUTION. From the Hawaiian Is to Mauritius.

H.matheroniana has not been illustrated by Deshayes (1859) nor by Reeve (1860), and the identity has long remained in doubt. The species has been described from specimens in Deshayes' own collection and a recent examination of the types of *H.matheroniana* shows the species to be conspecific with, and chronologically prior to *H.lauta* (Pease).

Acknowledgements. We wish to express our thanks to the curators and staff of the British Museum (Nat. Hist.), London, the Muséum National d'Histoire Naturelle, Paris, the École de Mines, Paris, and the Secretary, Linnean Society of London, for allowing access to their respective type-collections of Terebridae. To Dr H. Mienis, Hebrew University of Jerusalem, Mr. O. K. McCausland, Honolulu, Hawaii, and Mr Brian Parkinson, Rabaul, New Britain, we are grateful for the loan of terebrid specimens. We would like to thank Ms S. D. Kaicher, St. Petersburg, Florida, for having made prints from negatives of type-specimens of Terebridae.

REFERENCES

DESHAYES, G. P.

1859 A general review of the genus *Terebra*, and a description of new species. *Proc. Zool. Soc. London* Pt. 27: 270 - 321.

DODGE, H.

1956 A historical review of the Molluscs of Linnaeus. Part 4. The genera *Buccinum* and *Strombus* of the class Gastropoda. *Bull. Am. Mus. Nat. Hist.* 111 (3) : 153 - 312.

HINDS, R. B.

1844 *Monograph of the genus Terebra Bruguiere.* In G. B. Sowerby, *Thesaurus Conchyliorum*, London, G. B. Sowerby, 1 : 147 - 190, pl. 41 - 45.

REEVE, L.

1860 *Conchologia Iconica; monograph of the genus Terebra.* London, L. Reeve, 12 : pl. 1 - 27, Index.

THIELE, J.

1925 *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia"* 1898 - 1899. *Gastropoda der Deutschen Tiefsee-Expedition.* II Teil. Jena, G. Fischer, 17 (2) : 1 - 348, pl. 1 - 34 (13 - 46).

ON THE CONSIDERABLE INFLUX OF WARM WATER MOLLUSCS THAT HAVE INVADED NORTHERN NEW ZEALAND WATERS WITHIN RECENT YEARS

A. W. B. POWELL

AUCKLAND INSTITUTE AND MUSEUM

Abstract. The purpose of this paper is to bring together the numerous scattered records of tropical and subtropical molluscs that have invaded northern New Zealand waters within recent years and to attempt their evaluation individually as accidental, temporary, intermittent or permanent additions to the fauna. Seventy-six species of these new arrivals are discussed, but excluded are the considerable number of species of Australian or Indo-Pacific origin that are now so well established here that they have become an integral part of the fauna.

In evaluating the status of new additions to the fauna one must constantly bear in mind the unnatural factors that can operate, the main one being the role of shipping. A case in point was the recent finding of a living species of the Cypraeidae on the understructure of the "Penrod 74" floating oil rig upon its arrival at Whangarei Heads, after the long sea voyage from Singapore, and some months later, the finding of another species of this family still living while the rig was operating at a site off the Taranaki coast.

That shipping can operate in an opposite way, that is against the trend of ocean currents, is clearly evidenced in the abundant presence of two common otherwise endemic New Zealand molluscs in southern Tasmania. One is the chiton *Amaurochiton glaucus*, already well established there in 1901, and the other is *Maoricolpus roseus*, unknown in Tasmania prior to 1925. Since 1969 *roseus* has been trawled in quantity off Cape Moreton southern Queensland (Garrard 1972 : 322).

Another possible explanation of the spate of new arrivals to our shores is in the fleets of fast ocean-going foreign fishing vessels that could carry larvae in their constantly wet fishing nets and tackle.

Despite doubtful cases there is abundant evidence that natural causes are the main factors at work in this apparent spate of new arrivals to our shores. That the same trend was apparently operative in the New Zealand Pleistocene and earlier is shown by certain fossil records, *Limaria*, *Agnewia* and *Anadara*, to name a few.

Natural causes contributing to greatly accelerated influx of warm water molluscs and other invertebrates to our shores could be accounted for by a small increase in water temperature coupled with possible fluctuations in surface water currents, which would enable an increasing number of warm water species to colonise Northland waters.

Rec. Auckland Inst. Mus. 13: 141-166 December 10th, 1976

It would appear that some molluscs arriving here in their larval stage in massive strength manage to grow to adults but are unable to reproduce because of lower temperatures than their normal requirement. A case in point is *Hydatina physis* that persists here as an intermittent series of short lived invasions.

The past 8-10 years have been the most productive and the summer of 1972 the peak in this spate of warm water new arrivals.

SYSTEMATIC

CLASS GASTROPODA

Family STOMATELLIDAE

Stomatia phymotis Helbling, 1779

1779. *Stomatia phymotis* Helbling, Abh. Privatges. Böhm. 4 : 124.
1974. *Stomatia phymotis*: Powell, Rec. Auckland Inst. Mus. 11 : 204.

RANGE. Tropical Western Pacific; uncommon.

New Zealand Record. Te Araroa, East Cape, one empty shell in rock pool (Powell 1974).

Remarks. More evidence required before admitting this species to the New Zealand fauna.

Roya kermadecensis Iredale, 1912

1912. *Roya kermadecensis* Iredale, Proc. Malac. Soc. Lond. 10 : 218.
1934. *Roya sp.* Powell, Trans. R.Soc. N.Z. 64 : 155.

RANGE. Sunday Island (Raoul I), Kermadec Islands (Type locality), and Northland, New Zealand.

New Zealand Records. Tom Bowling Bay, Northland (Powell 1934); Goat Island Beach, Leigh, Hauraki Gulf, *leg.* A. W. B. Powell, *ca.* 1945; Poor Knights Is, 50 m, *leg.* N. Gardner, May, 1974.

Remarks. The above New Zealand records are based upon seven empty but well preserved shells. There is a New South Wales species, *Roya nutata* (Hedley, 1908), that appears to be closely related.

Family PLANAXIDAE

Hinea brasiliana (Lamarck, 1822)

1822. *Buccinum brasilianum* Lamarck, Hist. Anim. s. Vert. 7 : 272.
1913. *Planaxis (Hinea) brazilianus*: Suter, Man. N.Z. Moll: 194.
1952. *Hinea braziliana*: Powell, Rec. Auckland Inst. Mus. 4 (3) : 174.
1971. *Hinea brasiliana*: Powell, Rec. Auckland Inst. Mus. 8 : 209.

RANGE. Australia (Type locality, 'Brasil' = Sydney, New South Wales); Lord Howe Island; Kermadec Islands and Northland, New Zealand.

New Zealand Records. Bay of Islands (Suter 1913); Great Barrier I. *leg* Webster, *ca.* 1908; Rangiawhia Peninsula, Doubtless Bay, *leg.* W. Spencer, Dec. 1968.

Remarks. The species is now firmly established at Rangiawhia Peninsula.

Family EULIMIDAE

Eulima perspicua (Oliver, 1915)

1915. *Subularia perspicua* Oliver, Trans. N.Z. Inst. 47 : 533.
1940. *Eulima perspicua*: Powell, Trans. R. Soc. N.Z. 70 (3) : 234.

RANGE. Kermadec Islands, dredged (Type locality) and Northland, New Zealand.

New Zealand Records. Maro Tiri, Chicken Is; Tryphena, Great Barrier I, 5-6 fathoms (9.14-10.97 m) (Powell 1940).

Remarks. The species may be more widely distributed than the records indicate.

Balcis (Pictobalcis) articulata (Sowerby, 1834)

1834. *Eulima articulata* Sowerby, Proc. Zool. Soc. Lond. : 8.
1955. *Pictobalcis articulata*: Laseron, Aust. Zool. 12 (2) : 98, pl. 3, fig. 12.
1971. *Balcis (Pictobalcis) articulata*: Powell, Rec. Auckland Inst. Mus. 8 : 213, fig. 5.

RANGE. Eastern Australia (Type locality probably Moreton Bay); New South Wales and Northland, New Zealand.

New Zealand Records. Cape Maria van Diemen; Bay of Islands, a number, including 3 living (Poirieria 1972, 6 (5) : 100); between Bland Bay and Whangamumu (Powell 1971).

Remarks. The finding of living specimens and a number of well preserved ones over a period of years shows that the species is now firmly established in Northland waters.

Family HIPPONICIDAE

Hipponix cf **foliaceus** Quoy & Gaimard, 1834

1834. *Hipponix foliacea* Quoy & Gaimard, Voy. Astrol. Zool. 3 : 439.
1974. *Hipponix foliaceus*: Gardner, Poirieria 7(5) : 92.

RANGE. Guam (Type locality); New South Wales; ? northern New Zealand.

New Zealand Record. Poor Knights Is, western side of Tawhiti Rahi, 25 fathoms (45.72 m), 65 fairly well preserved examples accumulated in shell and bryozoan debris at base of steep cliff (Gardner 1974).

Remarks. Hipponix almost certainly lives at the above locality but at present its specific identification is tentative.

Family CAPULIDAE

Capulus (Krebsia) liberatus Pease, 1868

1868. *Capulus liberatus* Pease, Am. J. Conch. 3 : 287, pl. 24, fig. 2.
1964. *Tenpetasus liberatus*: Powell, Rec. Auckland Inst. Mus. 6 (1) : 12.

RANGE. Tropical and subtropical Indo-Pacific; Mauritius; Western Australia; New Hebrides; New Caledonia; Norfolk Island and Northland, New Zealand.

New Zealand Record. Bay of Islands, in beach drift at western end of Moturoa I, *leg.* H. C. Robinson, 1960.

Remarks. The species is most abundant at Norfolk Island. There have been no further New Zealand records.

Family CYPRAEIDAE

Erosaria cernica tomlini Schilder, 1930

1930. *Erosaria cernica tomlini* Schilder, Proc. Malac. Soc. Lond. 19 : 51.
1965. *Erosaria cernica tomlini*: Powell, Rec. Auckland Inst. Mus. 6 (2) : 164, pl. 23, figs. 15-19.
1971. *Erosaria cernica tomlini*: Cernohorsky, Rec. Auckland Inst. Mus. 8 : 121.

RANGE. Tropical and subtropical Pacific; Bonin and Ryuku Islands; Hawaiian Islands; Lifu, Loyalty Islands (Type locality); eastern Australia; Lord Howe Island; Kermadec Islands and Northland, New Zealand.

New Zealand Records. Cape Maria van Diemen (Island), one very worn and bleached shell, *leg.* F. Young, 1933; off Deep Water Cove, 23-25 fathoms (42.06-45.72 m); Poor Knights Is, living in sand amongst rubble and boulders at entrance to large cave, 20-30 m (Powell 1965).

Remarks. More than twenty living examples are known to have been found by skin divers at Poor Knights Islands.

Lyncina vitellus (Linnaeus, 1758)

1758. *Cypraea vitellus* Linnaeus, Syst. Nat. ed. 10 : 721.
1967. *Lyncina vitellus*: Powell, Rec. Auckland Inst. Mus. 6 (3) : 185.
1974. *Lyncina vitellus*: Powell, Rec. Auckland Inst. Mus. 11 : 205.

RANGE. Indo-Pacific, from Red Sea to Hawaiian Islands, Polynesia and Northland, New Zealand.

New Zealand Records. Poor Knights Is, at 90 feet (27.43 m), one alive and three well preserved shells; near Whangaroa, several fragments; Tutukaka, one fresh adult; Goat Island Bay, Leigh, two fresh adults at 15 feet (3.57 m) (Grange 1973 : 3).

Remarks. Evidently the species can grow to adult size in Northland waters but there is no evidence as yet that it breeds here.

Two other species of tropical Indo-Pacific cowries, *Erosaria erosa* (Linnaeus, 1758) and *Erosaria caputserpentis* (Linnaeus, 1758) have been found living in New Zealand waters associated with the "Penrod 74" floating oil rig which was built in Singapore, then towed to Whangarei Heads. There, Mr W. Palmer and associates found *erosa* on underwater structures of the rig. Six months later, after the rig had been towed to a new location off the Taranaki coast, five *caputserpentis* were found by Mr T. Hook enclosed in underwater drilling equipment (Hook 1975).

Family OVULIDAE

Volva (Phenacovolva) longirostrata (Sowerby, 1828)

1828. *Ovulum longirostratum* Sowerby, Zool. J. 4 (14): 160.
1971. *Volva (Phenacovolva) longirostrata*: Powell, Rec. Auckland Inst. Mus. 8 : 214, fig. 6.
1971. *Volva (Phenacovolva) longirostrata*: Cernohorsky, Rec. Auckland Inst. Mus. 8 : 126.

RANGE. Indo-Pacific (Type locality unknown); China Seas to northern New Zealand.

New Zealand Record. Poor Knights Is, a number at 150 feet (46 m), living on gorgonians (Powell 1971).

Pedicularia pacifica Pease, 1865

1865. *Pedicularia pacifica* Pease, Proc. Zool. Soc. Lond. : 516.
1903. *Pedicularia stylasteris* Hedley, Mem. Aust. Mus. 4 : 342.
1937. *Pedicularia maoria*: Powell, Discovery Rep. 15 : 208.
1971. *Pedicularia pacifica*: Cernohorsky, Rec. Auckland Inst. Mus. 8 : 116.

RANGE. Tropical Pacific; Gilbert Islands (Type locality); New South Wales and Northland, New Zealand, 100-260 m.

New Zealand Records. Off Three Kings Is, 260 m (Type of *maoria*); 30 miles (48 km) north of Three Kings Is, 200 m, over a dozen living on small branch of red coral (Poirieria 1972, 6 (5) : 86); Off Doubtless Bay, 110 m, on red coral, *leg.* W. Palmer, Dec. 1973.

Family CARINARIIDAE

Cardiapoda placenta (Lesson, 1830)

1830. *Pterotrachea placenta* Lesson, Voy. "Coquille" Zool. 2 (1) : 253.
1974. *Cardiapoda placenta*: Powell, Rec. Auckland Inst. Mus. 11 : 202.

RANGE. Atlantic and Pacific Oceans, pelagic; probably most tropical and subtropical waters.

New Zealand Record. Off Cape Brett, Northland from surface tow-netting, *leg.* N. Boustead, 1970-71.

Remarks. The shell is minute (*ca.* 2 mm) attached to a much larger semitransparent animal and hence easily overlooked.

Family NATICIDAE

Natica (Notocochlis) migratoria (Powell, 1927)

1927. *Cochlis migratoria* Powell, Trans. N.Z. Inst. 57 : 560.
1930. *Cochlis vafer* Finlay, Trans. N.Z. Inst. 61 : 232.

RANGE. New South Wales, Australia (*vafer*) and Northland, New Zealand. (*migratoria*).

New Zealand Records. Te Hapua, Parengarenga Harbour, low tide, living half buried under fine sand (Type locality); Awanui Heads (Powell 1927); off Deep Water Cove, Bay of Islands, in shallow water dredgings (Poirieria 1973, 7 (2) : 31).

Remarks. The species is established over a wide area in Parengarenga Harbour.

Conuber conica (Lamarck, 1822)

1822. *Natica conica* Lamarck, Anim. sans Vert. 6(2) : 198.
1952. *Conuber conica*: Powell, Rec. Auckland Inst. Mus. 4 (3) : 174.
1964. *Conuber conica*: Powell, Rec. Auckland Inst. Mus. 6 (1) : 12.

RANGE. Western Australia, Queensland, New South Wales, Victoria, Tasmania, South Australia and doubtfully Northland, New Zealand.

New Zealand Records. Tauranga Bay, Whangaroa, two half-grown fresh empty shells. Takau Bay, Northland, several well preserved empty shells, all immature (Powell 1952, 1964).

Remarks. Requires more evidence before admitting this species as a member of the New Zealand fauna.

Polinices (Mammilla) melanostomoides (Quoy & Gaimard, 1833)

1833. *Natica melanostomoides* Quoy & Gaimard, Voy. Astrolabe 2 : 229.

1971. *Polinices (Mammilla) melanostomoides*: Cernohorsky, Rec. Auckland Inst. Mus. 8 : 199, figs, 66, 67.

1974. *Polinices melanostomoides*: Powell, Rec. Auckland Inst. Mus. 11 : 201.

RANGE. New Guinea and New Ireland (Type locality); Fiji and northern Northland, New Zealand.

New Zealand Records. Te Hapua, Parengarenga Harbour, Northland, one empty shell on mud-flat, *leg.* K. Hipkins, February, 1972; entrance to Te Kao Channel, Parengarenga Harbour, one empty shell on mud-flat, *leg.* K. Hipkins, April, 1972; Rarawa Beach, Northland, one empty shell.

Polinices (Mammilla) mammatus (Röding, 1798)

1798. *Albula mammata* Röding, Mus. Bolten (2) : 21.

1937. *Mammilla mammata*: Powell, Shellfish of N.Z. : 73.

RANGE. Queensland, Australia and westward into Indian Ocean.

New Zealand Record. Takau Bay, Northland, one rather worn empty shell (Powell 1937).

Remarks. There have been no further New Zealand records.

Polinices (Mammilla) simiae (Deshayes, 1838)

1834. *Natica simiae* Deshayes, Hist. Nat. Anim. s. Vert. 8 : 652.

1964. *Mammilla simiae*: Powell, Rec. Auckland Inst. Mus. 6 (1) : 14.

RANGE. Tropical Pacific, Hawaiian Islands; Kermadec Islands; Queensland; New South Wales and northern New Zealand.

New Zealand Records. Cape Maria van Diemen, one fresh shell (Poirieria 1965, 2 (4) : 68); Day's Point, Kerikeri Inlet, Bay of Islands, one alive (Poirieria 1968, 4 (5) : 75); Deep Water Cove, Bay of Islands, one well preserved (Poirieria 1973, 7 (2) : 31); Oruawharo, Great Barrier I; Goat Island Beach, Leigh, Hauraki Gulf; Waihau Bay near East Cape, fresh examples (Powell 1964).

Polinices (Polinices) tawhitirahia Powell, 1965

1965. *Polinices tawhitirahia* Powell, Rec. Auckland Inst. Mus. 6 (2) : 163.

1967. *Polinices tawhitirahia*: Powell, Rec. Auckland Inst. Mus. 6 (3) : 185.

RANGE. Poor Knights Islands and adjacent mainland, 2-37 m; Norfolk Island, 45-50 fathoms (82.30-91.44 m).

New Zealand Records. Poor Knights Is, off Tawhiti Rahi, in sand and rubble at foot of cliff, 120 feet (36.58 m) (Type locality), three living and a number of fresh shells, *leg.* Mr W. Palmer and associates (Powell 1965, 1967); Bay of Islands, one alive in shallow water; Step I, Cavalli Is, several fresh shells (Poirieria 1973, 6 (6) : 115).

Family CASSIDAE

Semicassis bisulcata sophia (Brazier, 1872)

1872. *Cassis sophia* Brazier, Proc. Zool. Soc. Lond. : 617.

1968. *Phalium (Semicassis) bisulcatum sophia*: Abbott, Indo-Pacific Moll. 2 (9) : 131 pl. 8, fig. 12; pl. 15, figs. 1-8.

RANGE. Southern Queensland and New South Wales; Kermadec Islands and Northland, New Zealand.

New Zealand Record. Tutukaka, Northland east coast, one large well preserved example (Poirieria 1975, 8 (2) : 26).

Remarks. This shell, which I have not seen, is the only New Zealand record.

Xenophalium thomsoni (Brazier, 1875)

1875. *Cassis (Casmaria) thomsoni* Brazier, Proc. Linn. Soc. N.S.W. 1 : 8.

1964. *Xenophalium (Xenogalea) thomsoni*: Powell, Rec. Auckland Inst. Mus. 6 (1) : 13, pl. 3, figs. 4, 5.

RANGE. New South Wales (Type locality) to Bass Strait, Australia and northern New Zealand.

New Zealand Records. Great Exhibition Bay, one fresh example (Poirieria 1965, 2 (4) : 67); 30 miles (48 km) north of Mangonui, trawled and from crayfish pots, several shells; Whangaroa, 20-39 fathoms (36.58-71.32 m), several in crayfish pots; Great Barrier I, in crayfish pots; Marsden Point, Whangarei Heads, one beach shell (Powell 1964); off Aldermen Is, 180-310 fathoms (329.18-548.64 m), living; off Cuvier I, Bay of Plenty, living (Powell 1964).

Remarks. The species seems to be firmly established in northern New Zealand waters, although still uncommon.

Xenophalium royanum (Iredale, 1914)

1914. *Cassidea royana* Iredale, Proc. Malac. Soc. 11 (3) : 180.

1928. *Xenophalium royanum*: Powell, Trans. N.Z. Inst. 59 : 641, pl. 74, f. 11.

1967. *Xenophalium royanum*: Powell, Rec. Auckland Inst. Mus. 6 (3) : 187.

RANGE. New South Wales; Kermadec Islands (Type locality) and Northland, New Zealand.

New Zealand Records. Off Whangaroa, many well preserved shells from crayfish pots; off Cavalli Is, 20 fathoms (36.58 m) in crayfish pots; Poor Knights Is, 150 feet (4.57 m), a number of fresh shells and one alive, *leg.* Whangarei skin divers. *Remarks.* The species is now well established in Northland east coast waters. Skin divers operating off the Poor Knights state that *royanum* apparently feeds upon the giant heart-urchin *Brissus gigas* Fell, 1947.

Casmaria ponderosa perryi (Iredale, 1912)

1912. *Cassidea perryi* Iredale, Proc. Malac. Soc. Lond. 10 : 227.
1967. *Casmaria perryi*: Powell, Rec. Auckland Inst. Mus. 6 (3) : 186.

RANGE. Southeast Australia; Kermadec Islands (Type locality); Easter Island and northern New Zealand.

New Zealand Records. Oruawharu, Great Barrier I, one fresh adult and one juvenile from rocks just below low water (Powell 1967); off Deep Water Cove, Bay of Islands, one dead shell dredged in shallow water (Powell 1967).

Remarks. Possibly established, but rare.

Family TONNIDAE

Tonna cumingii (Reeve, 1849)

1849. *Dolium cumingii* Reeve, Conch. Iconica 5 : pl. 8, figs. 13b, 13c.
1931. *Parvitonna perselecta* Iredale, Rec. Aust. Mus. 18 : 216, pl. 23, fig. 17.
1938. *Tonna maoria* Powell, Rec. Auckland Inst. Mus. 2 (3) : 166, pl. 40, figs. 5, 6.
1971. *Tonna cumingii*: Powell, Rec. Auckland Inst. Mus. 8 : 215.

RANGE. Japan; China; Philippines; Indonesia; eastern Australia and Northland, New Zealand.

New Zealand Records. Houhora Heads, Northland, a well preserved empty shell (Type of *maoria* Powell, 1938); Tokerau Beach, Doubtless Bay, Northland, three well preserved empty shells (Powell 1971).

Remarks. There is no evidence that the species breeds in Northland waters.

Tonna luteostoma (Kuster, 1857)

1857. *Dolium luteostomum* Kuster, Conch. Cab. 3 : 66, pl. 38, fig. 2.
1971. *Tonna luteostoma*: Powell, Rec. Auckland Inst. Mus. 8 : 216, figs. 8, 9.

RANGE. Japan and ?New Zealand.
New Zealand Records. Beach south of Parengarenga Harbour, Northland, two empty shells in good condition, *leg.* A. E. Brookes, ca. 1925 (Powell 1971).

Remarks. No further evidence of this species in New Zealand waters.

Tonna dolium (Linnaeus, 1758)

1758. *Buccinum dolium* Linnaeus, Syst. Nat. ed. 10 : 735.
1952. *Tonna dolium*: Powell, Rec. Auckland Inst. Mus. 4 (3) : 177, pl. 35, fig. 5.
1964. *Tonna maculata* (Lamarck, 1822) = *dolium* Linnaeus,, 1758, Powell, Rec. Auckland Inst. Mus. 6 (1) : 15.

RANGE. Indo-Pacific; Indian Ocean; Indonesia: Japan; Philippines; Fiji and Northland, New Zealand.

New Zealand Records. South of Parengarenga Harbour, two adult empty shells (Powell 1964); Tokerau Beach, Doubtless Bay, three empty shells; off Whangaroa in crayfish pots; Mount Maunganui, Bay of Plenty, three adult empty shells (Powell 1952); trawled off Manukau Heads, one living (Powell 1964).

Remarks. The species is evidently established in northern New Zealand waters.

Tonna melanostoma (Jay, 1839)

1839. *Dolium melanostoma* Jay, Catal. of Shells ed. 3 : 125, pl. 8, 9.
1967. *Tonna melanostoma*: Powell, Rec. Auckland Inst. Mus. 6 (3) : 190, pl. 36, figs. 6, 7.

RANGE. Hawaiian Islands to Tonga, Society Islands, Melanesia and Northland, New Zealand.

New Zealand Records. Spirits Bay, one empty shell; off Cavalli Is, one living example, 86 mm in height; Doubtless Bay, trawled, evidently living (Powell 1967).

Tonna olearium (Linnaeus, 1758)

1758. *Buccinum olearium* Linnaeus, Syst. Nat. ed. 10 : 734.
1927. *Tonna tetracotula* (not of Hedley, 1919) : Powell, Trans. N.Z. Inst. 57 : 559, pl. 32.
1967. *Tonna olearium*: Powell, Rec. Auckland Inst. Mus. 6 (3) : 191.

RANGE. Japan; Indonesia; Philippines and northern New Zealand.

New Zealand Records. Outer Hauraki Gulf or Bay of Plenty, one trawled alive, *leg.* Powell, 1927; Doubtless Bay, five trawled shells (Poirieria 1967, 4 (2) : 24).

Remarks. The true *tetracotula* Hedley, 1919 is not uncommon, being often trawled off eastern Northland and the Bay of Plenty.

Tonna perdix (Linnaeus, 1758)

1758. *Buccinum perdix* Linnaeus, Syst. Nat. ed. 10 : 734.
1974. *Tonna perdix*: Powell, Rec. Auckland Inst. Mus. 11 : 204.

RANGE. Tropical Indo-Pacific and possibly Northland, New Zealand.

New Zealand Records. Beaches between Bay of Islands and North Cape, two small shells, one with portion of animal attached and several fragments cast ashore over past few years (Powell 1974).

Remarks. Insufficient evidence so far for including this species in the New Zealand fauna.

Malea pomum (Linnaeus, 1758)

1758. *Buccinum pomum* Linnaeus, Syst. Nat. ed. 10 : 735.
1974. *Malea pomum*: Powell, Rec. Auckland Inst. Mus. 11 : 204.

RANGE. Tropical Indo-Pacific and possibly New Zealand.

New Zealand Record. Great Exhibition Bay, Northland, one small well preserved shell, found by Mr Hunt Seelye, 1973 (Powell 1974).

Eudolium pyriforme (Sowerby, 1914)

1914. *Dolium pyriforme* Sowerby, Ann. Mag. Nat. Hist. 14 : 37.
1974. *Eudolium cf. pyriforme*: Powell, Rec. Auckland Inst. Mus. 11 : 201.
1976. *Eudolium pyriforme*: Cernohorsky, Auck. Mus. Conch. Sec. Bull. No. 1 (N.S.) : 1-2.

RANGE. Subtropical Pacific; Japan; Hawaiian Islands; New South Wales, Australia and northern New Zealand, 90-366 m.

New Zealand Records. Doubtless Bay, Northland, one large empty shell in good condition from a crayfish pot; another said to have been taken alive, from same area (Powell 1974); Cable Bay, Mangonui, one shell of record size, 106 mm in height; Tokomaru Reef, off Gisborne, 120 fathoms (219.5 m), one living (Cernohorsky 1976).

Family CYMATIIDAE

Charonia tritonis (Linnaeus, 1758)

1758. *Murex tritonis* Linnaeus, Syst. Nat. ed. 10: 754.
1964. *Charonia tritonis* Powell, Rec. Auckland Inst. Mus. 6(1) : 14.
1967. *Charonia tritonis* Powell, Rec. Auckland Inst. Mus. 6(3) : 187.
1970. *Charonia tritonis*: Beu, Trans. R. Soc. N.Z. Biol. Sci. 11(16) : 208.

RANGE. Indo-Pacific, East Africa to Polynesia; Hawaiian Islands; northern Australia, on sandy substrate in moderately deep water and possibly New Zealand.

New Zealand Records. Wainui Bay, Bay of Islands County, one near adult shell in fairly fresh condition (Powell 1964); Rosalie Bay, Great Barrier I, one adult shell (Powell 1967); unconfirmed reports of live examples taken in crayfish pots near Houhora (Beu 1970).

Remarks. Even if the larvae reach New Zealand at times and they grow into adults, they are unlikely to reproduce in local waters.

Charonia lampas rubicunda (Perry, 1811)

1811. *Septa rubicunda* Perry, Conchology, London : pl. 14, fig. 4.
1952. *Charonia rubicunda*: Powell, Rec. Auckland Inst. Mus. 4(3) : 175.
1970. *Charonia lampas rubicunda*: Beu, Trans. R. Soc. N.Z. Biol. Sci. 11(16) : 215.

RANGE. Southern Queensland; New South Wales; Victoria; South Australia; southern Western Australia and northern New Zealand.

Remarks. Prior to 1924, *rubicunda* was apparently an unknown subspecies in New Zealand but it has now become quite common in Northland, Manukau Harbour and the Bay of Plenty. However it seems to prefer a shallow water station.

Turritriton labiosus (Wood, 1828)

1828. *Murex labiosus* Wood, Index Test. Suppl.: 15, pl. 5, fig. 18.
1864. *Triton strangei* Adams & Angas, Proc. Zool. Soc. Lond. : 73.
1933. *Cabestana labiosa*: Powell, Trans. N.Z. Inst. 63 : 159, pl. 23, fig. 9.

RANGE. Tropical and subtropical Atlantic and Pacific; North Carolina to Brazil; Japan; Philippines; Fiji; eastern Australia; Kermadec Islands and Northland, New Zealand.

New Zealand Records. Tom Bowling Bay, Northland, one fresh empty shell (Powell 1933); Great Barrier I and Whangarei Heads, a few well preserved shells in local collections.

Family BURSIDAE

Bursa bubo lissostoma E. A. Smith, 1914

1914. *Bursa (Tutufa) rubeta* var. *lissostoma* E. A. Smith, J. of Conch. 24 : 230, pl. 4, fig. 3.
1967. *Tutufa bufo* (Röding 1798) : Powell, Rec. Auckland Inst. Mus. 6(3) : 189, pl. 36, fig. 8.
1974. *Bursa bubo lissostoma*: Powell, Rec. Auckland Inst. Mus. 11 : 205.

RANGE. Tropical Indo-Pacific; Japan; Solomon Islands; Melanesia; New South Wales; Kermadec Islands and Northland, New Zealand.

New Zealand Records. Off Spirits Bay, one fresh shell in crayfish pot (Poirieria 1971, 6(2) : 23); entrance to Te Kao Channel, Parengarenga Harbour, one living adult (Powell 1974); Doubtless Bay and North Cape areas, a number of well preserved adults from crayfish pots or cast ashore on beaches; off Cape Karekare, one live adult; Poor Knights Islands, 150 feet (45.72 m), one living adult female (Powell 1967); Rosalie Bay, Great Barrier I, one adult shell in crayfish pot (Poirieria 1968, 4(4) : 58).

Remarks. Upon the above evidence this subspecies can be considered firmly established in Northland waters.

Bursa verrucosa (Sowerby, 1825)

1825. *Ranella verrucosa* Sowerby, Cat. Coll. Tankerville, Append. : 18.
1965. *Annaperenna verrucosa*: Powell, Rec. Auckland Inst. Mus. 6(2): 162, pl. 22, figs. 5, 6.
1967. *Annaperenna verrucosa*: Powell, Rec. Auckland Inst. Mus. 6(3) : 190.

RANGE. Lord Howe Island; Norfolk Island (probable Type locality); Sydney Harbour, New South Wales (dredge spoil); Kermadec Islands and northern New Zealand.

New Zealand Records. Poor Knights Is, 50-150 feet (15-45.72 m), a number of fresh and living adults; off Club Rock, S.W. of White I, Bay of Plenty, 150 feet (45.72 m), living adults (Powell 1965, 1967).

Remarks. The species seems to be firmly established in our Northland off-shore waters on rocky ground.

Family MURICIDAE

Chicoreus ramosus (Linnaeus, 1758)

1758. *Murex ramosus* Linnaeus, Syst. Nat. ed. 10 : 747.
1908. *Murex ramosus*: Moss, Beautiful shells of N.Z. : 16.
1924. *Murex ramosus*: Bucknill, Sea shells of N.Z. : 67.
1964. *Chicoreus ramosus*: Powell, Rec. Auckland Inst. Mus. 6(1) : 15.

RANGE. Tropical Indo-Pacific.

New Zealand Records. Tauranga Harbour, Waikareao Estuary, two adults, one said to have been taken alive by Mrs T. M. Humphreys in 1903 (Moss 1908; Bucknill 1924); Takou Bay, Northland, one bleached adult, *leg.* Mr C. H. Robinson, *ca.* 1936; another from same locality, small but well preserved, *leg.* Mrs I. Worthy, *ca.* 1920 (Powell 1964).

Remarks. There is no evidence that the species reproduces in New Zealand waters.

Rapana venosa (Valenciennes, 1846)

1846. *Purpura venosa* Valenciennes, Voy. "Venus" : pl. 7, fig. 1.
1861. *Rapana thomasiana* Crosse, J. de Conchyl. 9 : 176, 268.
1974. *Rapana venosa*: Powell, Rec. Auckland Inst. Mus. 11 : 204.

RANGE. Japan, Korea and North China.

New Zealand Records. 12 miles (19.1 km) west of Cape Maria van Diemen, in crayfish pots *ca.* 48 fathoms (87.78 m), one adult shell in 1971 and another in same area in 1972, both inhabited by hermit crabs (Powell 1974); off Three Kings Is in crayfish pot, one large empty shell (Poirieria 1971, 5(6) : 117).

Remarks. There is a possibility that the above occurrences are not natural ones but are from discarded refuse from ocean going Asiatic fishing vessels. The species is an esteemed Japanese delicacy.

Trophon (Emozamia) licinus (Hedley & Petterd, 1906)

1906. *Murex licinus* Hedley & Petterd, Rec. Aust. Mus. 6(3) : 219, pl. 37.
1929. *Emozamia licina*: Iredale, Rec. Aust. Mus. 17(4) : 185.
1954. *Emozamia licina*: Powell, Rec. Auckland Inst. Mus. 4(4) : 238, pl. 39, figs. 5-7.

RANGE. New South Wales; off Sydney, 250 fathoms (457.20 m) (Type locality) and northern New Zealand.

New Zealand Records. N.N.E. of Mayor I, Bay of Plenty, 46-82 fathoms (84.12-149.96 m), one living; another well preserved one, precise locality unknown, from an Auckland trawler (Powell 1954).

Morula (Neothais) chaidea (Duclos, 1832)

1832. *Purpura chaidea* Duclos, Ann. Sci. Nat. 26(101) : 106.
1974. *Morula (Neothais) chaidea*: Powell, Rec. Auckland Inst. Mus. 11 : 202.

RANGE. New Caledonia; Lord Howe Island; Norfolk Island; Kermadec Islands; New South Wales and northern New Zealand.

New Zealand Records. Cape Brett, Bay of Islands, one living adult; Merita Bay, Rangiawhia Peninsula, Northland, living, half grown (Powell 1974); recently the species has shown a great increase in numbers found on intertidal rocks in the Bay of Islands and vicinity (Poirieria 1975, 8(1) : 2).

Remarks. An allied species, *Morula (Neothais) smithi* (Brazier, 1889), with a similar overseas range to that of *chaidea* has long been known to occur living in Northland waters, but is still uncommon, and the same applies to the somewhat related *Agnewia tritoniformis* (Blainville, 1833).

Family MAGILIDAE

Latiaxis wormaldi Powell, 1971

1971. *Latiaxis wormaldi* Powell, Rec. Auckland Inst. Mus. 8 : 220, figs. 15, 16.

New Zealand Record. E.S.E. of Poor Knights Is, 329 m, living, only known specimen, the Holotype (Auckland Museum Coll.).

Remarks. The species appears to be closely related to *Latiaxis marumai* Habe & Kosuge, 1970 from Japan.

Latiaxis lischkeanus (Dunker, 1882)

1882. *Rapana lischkeana* Dunker, Index Moll. Mar. Japan.
1947. *Tolema peregrina* Powell, Rec. Auckland Inst. Mus. 3(3): 171, pl. 19, fig. 3.
1955. *Tolema australis* Laseron, Proc. R. Zool. Soc. N.S.W. : 73.

RANGE. Japan (*lischkeanus*); New South Wales (*australis*) and northern New Zealand (*peregrina*).

New Zealand Records. Hauraki Gulf entrance, 20-25 fathoms (36.58-45.72 m); near Kawau I, Hauraki Gulf, 20 fathoms (36.58 m), two living adults; trawled off Kaipara Heads (Poirieria 1963 1(5) : 80); off Aldermen Is, 180-310 fathoms (329.18-601.67 m); trawled between Plate I and Motiti I, Bay of Plenty, 20-30 fathoms (36.58-54.86 m); off Mayor I, Bay of Plenty, 70 fathoms (128.02 m), all above living adults (Powell 1947; Poirieria 1971, 6(2) : 42).

Remarks. The above records show that the species is now well established in northern New Zealand waters.

Liniaxis sertata (Hedley, 1903)

1903. *Purpura sertata* Hedley, Mem. Aust. Mus. 4(6) : 382, figs. 95, 96.
1967. *Liniaxis sertata*: Powell, Rec. Auckland Inst. Mus. 6(3) : 193.

RANGE. New South Wales, off Port Kembla, 63-75 fathoms (115.21-137.16 m) (Type locality) and Northland, New Zealand.

New Zealand Records. Kopu Wairoa, Spirits Bay, Northland, one worn shell; North West Reef between Little Barrier I and Taranga, Hen I, 30 fathoms (54.86 m), three living adults on Antipatharian coral "sea-tree" (Powell 1967).

Family BUCCINIDAE

Ratifusus adjunctus Iredale, 1929

1929. *Ratifusus adjunctus* Iredale, Rec. Aust. Mus. 17(4) : 183.
1971. *Ratifusus adjunctus*: Powell, Rec. Auckland Inst. Mus. 8 : 222, fig. 23.

RANGE. New South Wales, off Montagu Island, 50-60 fathoms (91-110 m) (Type locality) and northern New Zealand.

New Zealand Record. E.S.E. of Poor Knights Is, 329 m, one adult attached to a piece of waterlogged wood (Powell 1971).

Family NASSARIIDAE

Nassarius (Alectrion) glans particeps (Hedley, 1915)

1915. *Arcularia particeps* Hedley, Proc. Linn. Soc. N.S.W. 39(4) : 738.
1972. *Nassarius particeps*: Powell, Rec. Auckland Inst. Mus. 4(3) : 182.

RANGE. New South Wales, Australia, Port Jackson (Type locality) and Northland, New Zealand.

New Zealand Records. Cavalli Islands, one dead shell, *leg.* W. La Roche, *ca.* 1924; only one other since, Matapouri, Northland, also dead.

Nassarius (Alectrion) spiratus (A. Adams, 1852)

1852. *Nassa spirata* A. Adams, Proc. Zool. Soc. Lond. for 1851 : 106.
1952. *Nassarius spiratus*: Powell, Rec. Auckland Inst. Mus. 4(3): 182.
1972. *Nassarius (Alectrion) spiratus*: Cernohorsky, Rec. Auckland Inst. Mus. 9 : 183, figs. 140, 148.

RANGE. Swan River, Western Australia (Type locality); New South Wales; Lord Howe Island; Norfolk Island; Kermadec Islands and Northland, New Zealand.

New Zealand Records. Tom Bowling Bay; Paua, Parengarenga Harbour to Bay of Islands, numerous living colonies, one such in shallow water consisted of over 200 adults (Poirieria 1975, 7(6) : 114); Matauri Bay; Cavalli Is; Whangaroa; Takau Bay; Matapouri Bay; Kaitoke and Arid I, Great Barrier I (Powell 1952).

Remarks. The species has shown a spectacular increase over the past year.

Family FASCIOLARIIDAE

Fasciolaria (Pleuroploca) filamentosa (Röding, 1798)

1798. *Fusus filamentosus* Röding, Mus. Bolten 2 : 118.
1974. *Fasciolaria (Pleuroploca) filamentosa*: Powell, Rec. Auckland Inst. Mus. 11 : 202.

RANGE. Tropical Indo-Pacific.

New Zealand Record. Near North Cape, one half grown shell from a crayfish pot (Powell 1974).

Fusinus genticus (Iredale, 1936)

1936. *Colus genticus* Iredale, Rec. Aust. Mus. 19 : 316.
1967. *Fusinus genticus*: Powell, Rec. Auckland Inst. Mus. 6(3): 194.
1974. *Fusinus genticus*: Powell, Rec. Auckland Inst. Mus. 11 : 205.

RANGE. New South Wales, Sydney Harbour in dredge spoil (Type locality) and Northland, New Zealand.

New Zealand Records. Great Exhibition Bay, one fresh adult and others from crayfish pots (Poirieria 1971, 6(1) : 1); Eastern Beach, Houhora, one fresh (Poirieria 1970, 5(5) : 81); Cavalli Is and vicinity of Doubtless Bay from crayfish pots, adult shells in good condition, *leg.* Mr S. E. Turner; Poor Knights Is, 120 feet (36.58 m), one very large living specimen 156 mm in height, *leg.* Mr W. Palmer, 1973 (Powell 1974).

Remarks. Apparently *genticus* is known in Australia only by the broken juvenile holotype (Poirieria 1973, 7(2) : 31). Since the species occurs in numbers in Northland waters and has been taken alive at the Poor Knights, it may well be that Northland is its stronghold and that the Sydney shell found its way there by chance means.

Fusinus novaehollandiae (Reeve, 1848)

1848. *Fusus novaehollandiae* Reeve, Conch. Iconica : pl. 18, fig. 70.
1968. *Fusinus novaehollandiae*: Ponder, Rec. Dominion Mus. 6(8) : 121.

RANGE. Continental shelf of eastern Australia and Tasmania.

New Zealand Records. Ohope Beach, Bay of Plenty, one well preserved shell (Ponder 1968); Opoutere Beach, Coromandel, one very worn shell, (Ponder 1968).

Latirus gibbulus (Gmelin, 1791)

1791. *Murex gibbulus* Gmelin, Syst. Nat. ed. 13 : 3557.
1965. *Latirus gibbulus*: Powell, Rec. Auckland Inst. Mus. 6(2) : 165, pl. 23, fig. 12.

RANGE. Tropical Pacific, Fiji and westward of there.

New Zealand Record. Mimiwhangata Beach, east coast north of Whangarei, after a storm, 1963, *leg.* Mrs B. C. le Clerc.

Remarks. There have been no further New Zealand records of this species which is very doubtfully living here.

Family TURRIDAE

Lophiotoma abbreviata (Reeve, 1843)

1843. *Pleurotoma abbreviata* Reeve, Conch Iconica 1 : pl. 10, fig. 86.
1974. *Lophiotoma abbreviata*: Powell, Rec. Auckland Inst. Mus. 11 : 205.

RANGE. Tropical Indo-Pacific; Mauritius to Fiji, a shallow water species found in sandy lagoons and under coral on reefs.

New Zealand Record. Deep Water Cove, Bay of Islands, one well preserved empty shell dredged in shallow water.

Remarks. Further evidence is required before admitting this species to the New Zealand fauna.

Family CONIDAE

Conus kermadecensis Iredale, 1912

1912. *Conus kermadecensis* Iredale, Proc. Malac. Soc. Lond. 10 : 227.
1972. *Conus kermadecensis*: Powell, Rec. Auckland Inst. Mus. 9 : 250, fig. 1.

RANGE. Kermadec Islands (Type locality) and Northland, New Zealand.

New Zealand Records. Parengarenga Harbour, one adult living on low-tidal sandbank at entrance to Te Kao Channel, *leg.* Mrs M. E. Armiger, January, 1972; also five more at same locality, *leg.* Master Andrew Wilson, March, 1972; Whangaroa Heads area, several living obtained by diving (Poirieria 1975, 7(6) : 114); Poor Knights, several obtained by skin-divers.

Family TEREBRIDAE

Terebra circumcincta Deshayes, 1857

1857. *Terebra circumcincta* Deshayes, J. de Conchyl. 6 : 77, pl. 3, fig. 9.
1971. *Terebra circumcincta*: Powell, Rec. Auckland Inst. Mus. 8 : 225, fig. 26.
1974. *Terebra circumcincta*: Powell, Rec. Auckland Inst. Mus. 11 : 206.

RANGE. Queensland (Type locality 'Red Sea' probably erroneous) and Northland, New Zealand.

New Zealand Records. Bay of Islands, dredged in shallow water, two living adults, *leg.* Mr & Mrs M. Hancock (Powell 1971); a small number of living adults have since been dredged in the same area, *leg.* Mr G. Clifford (Powell 1974).

Family ARCHITECTONICIDAE

Claraxis cf. illustris Iredale, 1936

1936. *Claraxis illustris* Iredale, Rec. Aust. Mus. 19(5) : 327.
1971. *Claraxis* cf. *illustris*: Powell, Rec. Auckland Inst. Mus. 8 : 212, figs.2-4.

RANGE. New South Wales, 45 fathoms (82.30 m) (Type locality) and northern New Zealand.

New Zealand Records. Off Mayor Island, Bay of Plenty, 82 m; between Mokohinau and Hen I, 55 fathoms (100.58 m).

Family EPITONIIDAE

Epitonium (Gyroscala) perplexum (Pease, 1867)

1867. *Scalaria perplexa* Pease, Am. J. Conch. 3(4) : 288.
1965. *Pomiscala perplexa*: Powell, Rec. Auckland Inst. Mus. 6(2) : 161.

RANGE. Hawaiian Islands (Type locality); Western Australia to Queensland; Kermadec Islands and Northland, New Zealand.

New Zealand Record. Paxton Point, Great Exhibition Bay, Northland, a few well preserved empty shells (Powell 1965).

Family JANTHINIDAE

Recluzia rollandiana Petit de la Saussaye, 1853

1840. *Janthina lutea* Bennett, Narr. Whaling Voy. 2 : 298 (indeterminate?)
1853. *Recluzia rollandiana* Petit de la Saussaye, J. de Conchyl. 4(1) : 119.
1924. *Recluzia lutea*: Powell, N.Z.J . Sci. Tech. 55 : 285.

RANGE. Tropical Pacific, Kermadec Islands and occasionally drifting to northern New Zealand.

New Zealand Records. Tryphena, Great Barrier I (Powell 1924); Mangawai and Whangamata.

Family ACTEONIDAE

Acteon variegatus (Bruguière 1789)

1789. *Bulimus variegatus Bruguière,* Meth., Vers. (1) : 336.
1972. *Acteon variegatus*: Cernohorsky, Marine shells of the Pacific 2 : 204, pl. 58, fig. 5.

RANGE. Tropical Pacific; and northern New Zealand.

New Zealand Record. Poor Knights Is, 40 m, one living adult (Poirieria 1975, 7(6) : 110).

Family HYDATINIDAE

Hydatina physis (Linnaeus, 1758)

1758. *Bulla physis* Linnaeus, Syst. Nat., ed. 10 : 727.
1924. *Hydatina physis*: Powell, N.Z. J. Sci. Tech. 6(5-6) : 284.
1964. *Hydatina physis*: Powell, Rec. Auckland Inst. Mus. 6(1) : 18.

RANGE. Indo-Pacific; Hawaiian Islands; Japan: Queensland; Norfolk Island; New South Wales and Northland, New Zealand.

New Zealand Records. Tryphena and Port Fitzroy, Great Barrier I, living adults (Powell 1924); Takou Bay, Northland, about 25 living adults; Whangaroa and Houhora Harbours on mud-flats, May, 1961; Parengarenga Harbour, several colonies reported within recent years (Powell 1964).

Remarks. Temporary colonies resulting from chance spat-falls; individuals grow to maturity but evidently cannot reproduce under local conditions.

Hydatina albocincta (Van der Hoeven, 1839)

1839. *Bulla albocinta* Van der Hoeven, Tijdschr. nat. phys. 6(4) : 245, pl. 10.
1971. *Hydatina albocincta*: Powell, Rec. Auckland Inst. Mus. 8 : 227.

RANGE. Japan; China; Formosa; Philippines; Queensland and Northland, New Zealand.

New Zealand Records. Tutukaka, Northland, one fresh adult (Powell 1971); north end of Doubtless Bay, Northland, one fresh adult (Poirieria 1974, 7(5) : 99).

Family PHILINIDAE

Philine angasi Crosse & Fischer, 1865

1865. *Philine angasi* Crosse & Fischer, J. de Conchyl. 13 : 38.
1934. *Philine angasi*: Powell, Trans. N.Z. Inst. 64 : 160.

RANGE. South Australia to New South Wales and northern New Zealand.

New Zealand Records. Parengarenga Harbour; Mansion House Bay, Kawau I (Powell 1934); Cheltenham, Auckland; Firth of Thames and Manukau Harbour.

Family BULLIDAE

Bulla vernicosa Gould, 1859

1859. *Bulla vernicosa* Gould, Proc. Boston Soc. Nat. Hist. 7 : 138.
1913. *Bullaria adamsi*: (non Menke 1850). Suter, Man. N.Z. Moll. : 534.
1965. *Bulla (Quibulla) subtropicalis* Powell, Rec. Auckland Inst. Mus. 6(2) : 167, pl. 22, figs. 8, 9.

RANGE. Japan; Ryukyu Islands (Type locality); Fiji; Norfolk Island; Kermadec Islands; eastern Australia and Northland, New Zealand.

New Zealand Records. Cape Maria van Diemen to Whangarei Heads; well preserved shells frequently wash ashore.

Family ATYIDAE

Atys naucum (Linnaeus, 1758)

1758. *Bulla naucum* Linnaeus, Syst. Nat. ed. 10 : 726.
1965. *Atys naucum*: Powell, Rec. Auckland Inst. Mus. 6(2) : 168.

RANGE. Throughout the tropical Indo-Pacific.

New Zealand Records. Snell's Beach, Warkworth, two not fully adult empty shells, *leg.* Mr. J. R. Penniket (Powell 1965); several more from the same locality (Poirieria 1970, 5(5) : 81).

Limulatys reliquus Iredale, 1936

1836. *Limulatys reliquus* Iredale, Rec. Aust. Mus. 19(5) : 328.
1964. *Limulatys reliquus*: Powell, Rec. Auckland. Inst. Mus. 6(1) : 18, pl. 3, fig. 6.

RANGE. New South Wales, Sydney Harbour dredgings (Type locality).

New Zealand Records. East of Stephenson I, Whangaroa, 16-17 fathoms (29.26-31.09 m), two well preserved shells (Powell 1964); Great Exhibition Bay, one fresh shell (Poirieria 1973, 7(1) : 19).

Family APLYSIIDAE

Dolabrifera brazieri Sowerby, 1870

1870. *Dolabrifera brazieri* Sowerby, Proc. Zool. Soc. Lond. : 250.
1967. *Dolabrifera brazieri*: Powell, Rec. Auckland Inst. Mus. 6(3) : 195.

RANGE. New South Wales, Botany Bay (Type locality) and Northland, New Zealand.

New Zealand Record. Taiharuru, Pataua, Whangarei Heads, three living in low tidal gutters among rocks, *leg.* Mrs I. Worthy (Powell 1967).

Family UMBRACULIDAE

Umbraculum sinicum (Gmelin, 1791)

1971. *Patella sinica* Gmelin, Syst. Nat., ed. 13, 1 : 3705.
1913. *Umbraculum umbellum* (Martyn) Suter, Man. N.Z. Moll. : 549.
1923. *Umbraculum botanicum* Hedley, Proc. Linn. Soc. N.S.W. 48 : 315, pl. 32.
1924. *Umbraculum botanicum*: Powell, N.Z. J. Sci. Tech. 5(5-6) : 286.

RANGE. Indo-Pacific, East Africa to Hawaii; Australia; Kermadec Islands and Northland, New Zealand.

New Zealand Records. Northland east coast; off Te Hapua, Parengarenga Harbour, *leg.* R. Willan, April, 1976; Bay of Islands, *leg.* J. C. Anderson; vicinity of Hen and Chicken Is, 25-30 fathoms (45.72-54.86 m) (Powell 1924).

Family GYMNODORIDAE

Nembrotha kubaryana Bergh, 1877

1877. *Nembrotha kubaryana* Bergh, Malacol. Unters. Semper, Sec. 2(11) : 454.
1971. *Nembrotha kubaryana*: Miller in Doak, Beneath N.Z. Seas, pl. 36, fig. A.

RANGE. Palau Islands (Type locality) and Northland, New Zealand.

New Zealand Record. Poor Knights Is.

Nembrotha morosa Bergh, 1877

1877. *Nembrotha morosa* Bergh, Malacol. Unters. Semper, Sec. 2(11) : 457.
1971. *Nembrotha morosa*: Miller in Doak, Beneath N.Z. Seas : pl. 36, fig. B.

RANGE. Philippines Sea (Type locality) and Northland, New Zealand.

New Zealand Record. Poor Knights Is.

Family GLAUCIDAE

Glaucus atlanticus Forster, 1777

1777. *Glaucus atlanticus* Forster, Voy. round the World . . . sloop Resolution . . . : 49.
1937. *Glaucilla atlantica*: Powell, Rec. Auckland Inst. Mus. 2(2) : 124.
1974. *Glaucus atlanticus*: Miller, Zool. J. Linn. Soc. : 54.

RANGE. Atlantic, Pacific and Northern New Zealand; pelagic.

New Zealand Records. Mairangi Bay, Auckland, *leg.* Powell, October, 1934 (Powell 1937); Muriwai Beach, Auckland west coast, October, 1971; Matai Bay, Cape Karekare, Northland, *leg.* D. M. Hole, (Poirieria 1975, 7(6) : 115).

CLASS BIVALVIA

Family MYTILIDAE

Septifer bilocularis (Linnaeus, 1758)

1758. *Mytilus bilocularis* Linnaeus, Syst. Nat. ed. 10 : 705.
1954. *Septifer* cf. *bilocularis*: Powell, Rec. Auckland Inst. Mus. 4(4) : 235.

RANGE. Tropical Indo-Pacific and Northland, New Zealand.

New Zealand Records. Off Mayor I, Bay of Plenty, 45 fathoms (82.30 m), juvenile from stomach of fish (*Dactylopagrus macropterus* Forster); Poor Knights Is in sublittoral shell-sand, several valves (Poirieria 1966, 3(4-5) : 70); same locality at 40-45 m, numerous odd valves up to 10 mm in length, *leg.* N. Gardner, 1974.

Family PTERIIDAE

Pteria levitata (Iredale, 1939)

1939. *Austropteria levitata* Iredale, Moll. Great Barrier Reef Exped. Brit. Mus. (Nat. Hist.): 331, pl. 5, fig. 12.

RANGE. Queensland, dredged at Port Curtis, living on Alcyonarian (Type locality) and Poor Knights Islands, New Zealand.

New Zealand Record. Poor Knights I, 150 feet (45.72 m), on Alcyonarians. A new addition to the New Zealand fauna.

Remarks. Another member of this family, a widely distributed rather small tropical Pacific pearl oyster, *Pinctada fucata* (Gould, 1850) (= *martensii* Dunker, 1872) was found alive, attached to a coconut, washed ashore on Urupukupuka Island, Bay of Islands (Poirieria 1973, 6(6) : 115). This record of course has no faunal significance.

Family OSTREIDAE

Crassostrea gigas (Thumberg, 1793)

1793. *Ostrea gigas* Thunberg, K. Vet. Ac. Nya. Handl. 14 : 140.

1971. *Crassostrea gigas*: Dinamani, N.Z. J. Mar. Frewshw. Res. 5(2) : 352-357.

RANGE. Natural: Japan (Type locality), Korea and vicinity. Introduced and cultivated: Pacific coast of North America; eastern coast of United States; Hawaii; Okinawa; New South Wales and Tasmania.

New Zealand Records. Mahurangi oyster farm, first observed in January, 1961. Since accidentally distributed along with *glomerata* oyster seed to oyster farms in Kaipara Harbour, Bay of Islands and Ohiwa Harbour, Bay of Plenty (Dinamani 1971).

Remarks. Dinamani (1971) considers that the 2-3 weeks normal larval life of this oyster is insufficient to enable a 1,200 mile (1,900 km) successful drift across the Tasman and suggests chance means as the only alternative.

Lopha cristagalli (Linnaeus, 1758)

1758. *Mytilus crista galli* Linnaeus, Syst. Nat. ed. 10 : 704.

RANGE. Tropical Indo-Pacific.

Remarks. Ten examples, some fully adult, attached to a length of rope, were hauled up off Parengarenga Heads. They probably originated from some foreign trawler operating off the New Zealand coast (Poirieria 1971, 5(6) : 104). This record cannot be accepted as a natural addition to the New Zealand fauna.

Family LIMIDAE

Limaria orientalis (Adams & Reeve, 1850)

1850. *Lima orientalis* Adams & Reeve, Zool. Samarang 7 : 75.
1926. *Lima marwicki* Powell, Rec. Canterbury Mus. 3(1) : 48.
1974. *Limaria orientalis*: Powell, Rec. Auckland Inst. Mus. 11 : 203.
1976. *Limaria (Promantellum) orientalis*: Grange, Veliger 17(1) : 13.
1976. *Limaria orientalis*: Climo, Conch. Sec. Auck. Inst. Mus. Bull. No. 1 (N.S.) : 14.

RANGE. Japan; Philippines (Type locality); New South Wales; Victoria; South Australia and New Zealand.

New Zealand Records. Not known Recent in New Zealand prior to January, 1972 but now very abundant in northern North I., Russell, Bay of Islands, common off shore (Poirieria 1975, 8(1) : 17); Goat Island Beach, Leigh (site of first New Zealand Recent record); Wenderholm, near Waiwera, in tidal rock pools; Colville Passage, 10-12 fathoms (18.29-21.95 m); outer coast of Coromandel Peninsula down to Mercury Bay; Auckland east coast beaches, cast ashore in considerable numbers, especially at Cheltenham and Takapuna, during gales in early April, 1976.

Remarks. The recent invasion is probably analogous to several short-lived ones in the geological past, for *orientalis* seems to be inseparable from *marwicki* Powell, 1926 from the upper Pleistocene of Castlecliff, Wanganui, and a damaged valve from the Miocene of Target Gully, Oamaru seems to be the same species also.

Family TELLINIDAE

Tellina (Arcopaginula) inflata Gmelin, 1791

1791. *Tellina inflata* Gmelin, Syst. Nat., ed. 13, 1 : 3230.

RANGE. Tropical Western Pacific.

New Zealand Record. Off Mahia Peninsula, 150 fathoms (274.32 m), trawled alive (Poirieria 1971, 6(2) : 26).

Remarks. I have not seen this specimen.

Family SEMELIDAE

Theora (Endopleura) lubrica Gould, 1861

1861. *Theora lubrica* Gould, Proc. Boston Soc. Nat. Hist. 8 : 24.
1974. *Theora (Endopleura)* lubrica: Powell, Rec. Auckland Inst. Mus. 11 : 203.
1976. *Theora (Endopleura) lubrica*: Climo, Conch. Sec. Auckland Inst. Mus. Bull. No. 1 (N.S.) : 11-16.

RANGE. *Japan* (Type locality); Botany Bay, New South Wales, Australia (based upon *Neaera fragilis* A. Adams, 1855, a probable synonym of *Theora lubrica*); and numerous New Zealand records down to as far south as Marlborough Sounds (Climo 1976).

New Zealand Records. Not known in New Zealand prior to 1972. North I: Owhanga Bay, Whangaroa Harbour, 12 m, February, 1974 (Climo 1976); Bay of Islands in shallow water soft mud; Tutukaka in low tidal mud, *leg.* R. C. Willan, 1972; Auckland Harbour, Shoal Bay near Harbour Bridge and extending up harbour to Island Bay, abundant in low tidal mud, 1972, but less abundant subsequently. South I: Pelorus Sound, Marlborough, August, 1975, dredged alive in abundance in 34 and 48-50 m (Climo 1976).

Remarks. This massive invasion that probably took place during the summer of 1972 covered such a wide area that a natural cause by means of larval drift is more plausible than one involving shipping.

Family POROMYIDAE

Poromya laevis E. A. Smith, 1885

1885. *Poromya laevis* E. A. Smith, "Challenger" Zool. 13 : 55, pl. 11, figs. 3, 3b.
1966. *Poromya laevis*: Crozier, Trans. R. Soc. N.Z. Zool. 8(5) : 45.

RANGE. North Australia, east of Cape York, 155 fathoms (283 m) (Type locality).

New Zealand Record. North of Three Kings Is, 440 fathoms (804.67 m) Crozier 1966).

Family MYOCHAMIDAE

Myochama tasmanica (Tenison-Woods, 1877)

1877. *Gouldia tasmanica* Tenison-Woods, Proc. R. Soc. Tasmania : 160.
1974. *Myochama tasmanica*: Powell, Rec. Auckland Inst. Mus. 11 : 197, figs. 1-8.

RANGE. Southern Tasmania (Type locality); New South Wales and far north of New Zealand.

New Zealand Records. Parengarenga Harbour, Northland, 3-4 fathoms (5.48-7.31 m attached to exterior of living and the interior of dead *Tawera spissa* and *Paphies australis*.

Family VERTICORDIIDAE

Spinosipella ericia (Hedley, 1911)

1911. *Verticordia ericea* Hedley, Biol. Res. "Endeavour" Pt. 1 : 96.
1966. *Spinosipella ericia*: Crozier, Trans. R. Soc. N.Z. Zool. 8(5) : 45.

RANGE. South Australia (Type locality), New South Wales and Queensland; also off Cape Vidal, Zululand, 80-100 fathoms (146.30-182.88 m) and off Madagascar, 400 m (Crozier 1966).

New Zealand Record. Off Three Kings Is, 440 fathoms (804.67 m) (Crozier 1966).

REFERENCES

BEU, A. G.

1970 The Mollusca of the Genus *Charonia* (Family Cymatiidae). *Trans. R. Soc. N.Z. Biol. Sci.* 11(16) : 205-223.

BUCKNILL, C. E. R.

1924 *Sea Shells of New Zealand.* Whitcombe & Tombs, Auckland. 123 pp.; 12 pls.

CERNOHORSKY, W. O.

1976 Notes on the Genus *Eudolium* Dall, 1889. *Auckland Mus. Conch. Sec. Bull.* No. 1 (New Series) : 1 - 2.

CLIMO, F. M.

1976 The occurrence of *Theora (Endopleura) lubrica* Gould, 1861 (Mollusca : Bivalvia : Semelidae) in New Zealand. *Auckland Mus. Conch. Sec. Bull.* No. 1 (New Series): 11 - 16.

CROZIER, M. A.

1966 New species and records of Mollusca from off Three Kings Islands, New Zealand. *Trans. R. Soc. N.Z. Zool.* 8(5) : 39 - 49.

DINAMANI, F.

1971 Occurrence of the Japanese oyster *Crassostrea gigas* (Thunberg) in Northland, New Zealand. *N.Z.J.Mar. Freshw. Res.* 5(2) : 352-357.

GARDNER, N. W.

1974 On the ocurrence of a species of *Hipponyx* from northern New Zealand. *Poirieria* 7 (5) : 92 - 93.

GARRARD, T. A.

1972 A revision of Australian Recent and Tertiary Turritellidae (Gastropoda : Mollusca). *J. Malac. Soc. Aust.* : 267 - 337; pls. 26 - 30.

GRANGE, K.

1973 *Cypraea vitellus* in New Zealand. *Poirieria* 7(1) : 3-4.

HOOK, T.

1975 Cowries in Taranaki waters? *Poirieria* 8(1) : 2 - 5.

MOSS, E. G. B.

1908. *The beautiful shells of New Zealand.* Collins, Auckland. 46 pp. 10 pls.

POIRIERIA, Editorial Notes from

1963-1975 *Poirieria.* Conchology Section, Auckland Institute and Museum. 1963 1(5 : 80. 1965 2(4) : 67, 68. 1966 3(4-5) : 70. 1967 4(2) : 24. 1968 4(4) : 58; 4(5) : 75. 1970 5(5) : 81. 1971 5(6); 104, 117; 6(1) : 1; 6(2) : 23, 26, 42. 1972 6(5) : 86, 100. 1973 6(6) : 115; 7(1) : 19; 7(2) : 31. 1974 7(5) : 99. 1975 7(6) : 110, 114, 115; 8(1) : 17; 8(2) : 2, 26.

PONDER, W. F.

1968 Notes on New Zealand Prosobranchs with descriptions of new species and subspecies. *Rec. Dominion Mus.* 6(8) : 113 - 124.

POWELL, A. W. B.

1924 Notes on New Zealand Mollusca. *N.Z.J. Sci. Tech.* 6(5 - 6) : 282-286.

1927 On a large *Tonna* and two other Gastropods of Australian origin. *Trans. Proc. N.Z. Inst.* 57 : 559 - 562.

1933 Notes on the taxonomy of the Recent Cymatiidae and Naticidae of New Zealand. *Trans. Proc. N.Z. Inst.* 63(2) : 154 - 170.

1934 Gasteropods new to the New Zealand fauna; with descriptions of six new species and a new subspecies. *Trans. Proc. R. Soc. N.Z.* 64 (2) : 154 - 160.

1937 *Shellfish of New Zealand.* Unity Press, Auckland. 100 pp.; 18 pls.

1940 The marine Mollusca of the Aupourian Province, New Zealand. *Trans. Proc. R. Soc. N.Z.* 70(3) : 205 - 248.

1952 New Zealand molluscan systematics, with descriptions of new species, Part 1. *Rec. Auckland Inst. Mus.* 4(3) : 169 - 185.

1954 New Zealand mollusca systematics, with descriptions of new species, Part 2. *Rec. Auckland Inst. Mus.* 4(4) : 235 - 240.

1964 New Zealand molluscan systematics with descriptions of new species: Part 4. *Rec. Auckland Inst. Mus.* 6(1) : 11 - 20.

1965 New Zealand molluscan systematics with descriptions of new species: Part 5. *Rec. Auckland Inst. Mus.* 6(2) : 161 - 168.

1967 New Zealand molluscan systematics with descriptions of new species; Part 6. *Rec. Auckland Inst. Mus.* 6(3) : 185 - 196.

1971 New Zealand molluscan systematics with description of new species; Part 7. *Rec. Auckland Inst. Mus.* 8 : 209 - 228.

1974 New Zealand molluscan systematics with descriptions of new species; Part 8. *Rec. Auckland Inst. Mus.* 11 : 197 - 207.

SUTER, H.

1913 *Manual of the New Zealand Mollusca.* Government Printer, Wellington. 1120 pp.

GILL DAMAGE IN FISH PRODUCED BY BUCCAL PARASITES

A. B. STEPHENSON

AUCKLAND INSTITUTE AND MUSEUM

Abstract. The buccal parasites *Codonophilus imbricatus* (Fabricius) and *Irona melanosticta* Schiodte & Meinert (Isopoda : Cymothoidae), were found to cause gill damage in fish through the abrasive action of peraeopods on gill lamellae, and, by virtue of gross size, to physically limit the inward growth of gill rakers. Gill damage is considered more permanent than superficial skin erosion and has been found a useful guide to previous parasitism after the parasite is removed or lost.

Skin damage in fish, caused by some cymothoid ectoparasites, has been related to parasite feeding activities (Hale 1926, Bowman & Mariscal 1968) but, because damage is superficial, fairly rapid healing should occur once the parasite is removed. In contrast the erosion of gill lamellae, Bowman (1960), Turner & Roe (1967), and operculum abrasion Briggs (1970), by parasites have a physical origin and are not consequential of feeding. Because hard tissues are involved these conditions may persist for some time after the parasite is lost.

In studies of New Zealand jack mackerels *Trachurus* spp. and the garfish *Hyporohamphus ihi* (Phillipps), it was found, after the removal of their respective buccal parasites *Codonophilus imbricatus* (Fabricius) and *Irona melanosticta* Schiodte & Meinert (Isopoda : Cymothoidae), that in addition to the erosion of gill lamellae, the inward growth of gill rakers had been displaced. In some older fish a callus-like tissue had formed over the ventral bucco-pharynx. It is considered that the gross size and shape of parasites acts as a physical irritant to the bucco-branchial tissues, and is responsible for the observed damage.

Samples of the fishes *Trachurus declivis* (Jenyns), *T. novaezelandiae* (Richardson) and *Hyporohamphus ihi* were collected for previous studies (Stephenson unpublished 1971, Stephenson & Robertson in press) from various coastal localities. Individual fish were measured for standard length (SL), after Hubbs & Lagler (1947) and examined for the presence or absence of isopods. Juvenile and male parasites were found over the gill surfaces, but prospective and mature females occupy a bucco-pharyngeal position grasping the cartilagenous tongue (glossohyal) and always facing towards the mouth opening. Isopods were extracted and preserved separately to avoid subsequent handling losses; sufficient data being recorded to ensure a future cross-reference between parasites and their host.

Gill damage was noted while taking standard gill raker counts from dissected first gill arch, usually left side, of each fish. Observations were made with the aid of a steroscopic microscope and where additional clarity was required the material was briefly stained in alkaline Alizarin — Red S.

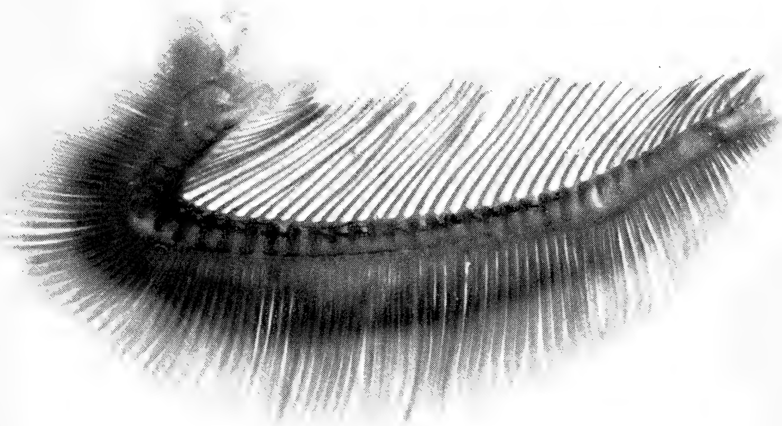


Fig. 1. *Trachurus novaezelandiae* SL 10.9 cm. Inner face of undamaged first gill arch; parasite absent.

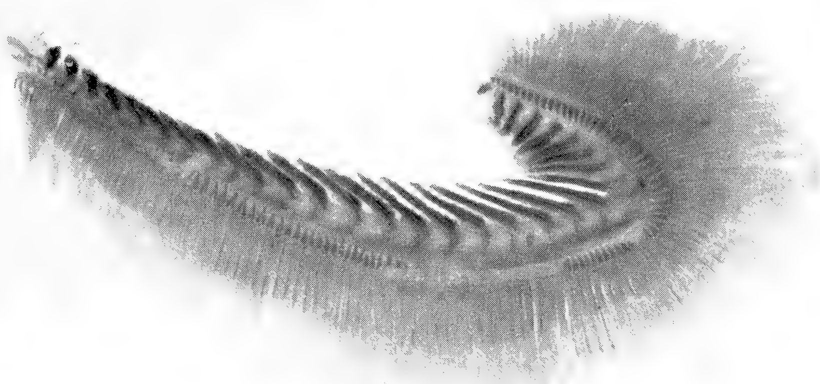


Fig. 2. *Hyporohamphus ihi.* SL 19.1 cm. Outer face of undamaged first gill arch; parasite absent.

Fig. 3. *Trachurus novaezelandiae*. SL 8.7 cm. Damaged inner face of first gill arch; parasite present.

Fig. 4. *Hyporohamphus ihi*. SL 16.5 cm. Damaged inner face of first gill arch; parasite present.

Results

The undamaged appearance of the first gill arch is shown respectively for *Trachurus novaezelandiae* (Fig. 1) and *Hyporohamphus ihi* (Fig. 2). They are characterised by a regularity in distribution and profile of gill rakers and lamellae along the branchial arch. In both genera gill rakers are narrowly lanceolate; sparingly bristled along inner borders. Total gill raker counts along the first gill arch are mostly in the range 49-59 for *Trachurus novaezelandiae* and 47-57 for *T. declivis* (Stephenson & Robertson in press). In *Hyporohamphus ihi* it is usually 28-30 (Collette 1974). Although rakers often appeared to be more widely spaced in parasitised fish their raker counts are not significantly different from uninfected individuals (Table 1).

Gill damage was intimately linked with parasites collected from the buccal cavity or the branchial arches. The degree of damage, however, was variable in nature and intensity but did not appear to be species related. Amongst the general conditions observed were the erosion of gill lamellae, the disruption and stunted growth of gill rakers (Figs. 3, 4), and a callus-like thickening (dystrophic calcification) over inner edges of the gill rakers and branchial arch (Fig. 5). The transitional nature of the damage made it impracticable to categorise these conditions.

Some large jack mackerel (above 35.0 cm, SL) showed raker damage of a quite different type (Fig. 6) where only the raker tips are thickened or bent, and occasional rakers were bifurcate. This could not be directly linked with previous parasitism, there being no parasites amongst the fish examined (Table 1) or recorded from the total catch (D. R. Robertson pers. comm.).

Discussion

The extent of gill damage may reflect the duration of infection since eroded gill lamellae were noticed more frequently in very young fish, while stunted rakers and callus formation appeared confined to fish usually from 2-5 yr. old. There are, however, difficulties in interpretation. Some large buccal parasites were found with their anterior peraeopods grasping through the gill arch and in contact with lamellae. Gill lamellae are also the sites of attachment for juveniles and males. In both cases lamellae damage could be sustained in older fish.

During early years of a host's life it appears probable that physical contact between a buccal parasite and the host's gill rakers would be more or less continual. In addition movements of the hyoid apparatus in gill ventilation and food swallowing would create frictional irritation between these surfaces. This feature is regarded as the main cause of gill damage recognised in this report.

Because gill raker damage involves the alteration in shape of hard tissue it may, on its own, be a useful guide to previous buccal isopod parasitism. This has been found practical, at least in the short term, where parasites often crawl or dislodge from their hosts during capture and examination.

Fig. 5. *Trachurus declivis*. SL 13.1 cm. Advanced damage to inner face of first gill arch; parasite present.

Fig. 6. *Trachurus declivis*. SL 44.0 cm. Raker tip anomaly, viewed from inner face of first gill arch; parasite absent.

Table 1. Length and gill condition of fish examined for isopod parasites.

Species	Standard Length cm	Gill raker count	Parasite present	Parasite absent	Gill damage present	Gill damage absent
Trachurus declivis	3.5	11 + 31	X		X	
	4.1	11 + 32	X		X	
	4.2	11 + 36	X		X	
	4.5	12 + 34	X		X	
	4.5	12 + 32	X		X	
	4.7	11 + 36	X		X	
	5.0	14 + 36		X		X
	5.1	12 + 36		X		X
	8.7	14 + 37		X		X
	13.6	13 + 41	X		X	
	13.8	13 + 38	X		X	
	14.1	14 + 40		X		X
	15.2	14 + 39		X		X
	15.3	14 + 42		X		X
	15.5	14 + 40		X		X
	16.0	13 + 40		X		X
	16.1	13 + 39		X		X
	16.2	14 + 39		X	X	
	17.5	15 + 40	X		X	
	17.7	15 + 40	X		X	
	18.0	13 + 40		X	X	
	18.2	15 + 41		X		X
	18.5	14 + 40	X		X	
	19.5	15 + 41		X		X
	20.6	14 + 40		X		X
	32.0	14 + 41		X		X
	33.0	14 + 38		X	X	
	43.5	14 + 40		X		X
	43.5	14 + 37		X		X
	44.0	15 + 39		X	X	
	44.0	14 + 37		X	X	
	45.0	15 + 37		X		X
	45.0	14 + 40		X		X
	45.5	14 + 36		X		X
	46.0	14 + 39		X		X
	46.0	15 + 38		X	X	
	46.5	14 + 38		X		X
	47.0	14 + 38		X		X
Trachurus novaezelandiae	5.6	15 + 38		X		X
	7.0	14 + 40	X		X	
	8.3	14 + 38	X		X	
	8.3	15 + 40		X		X
	8.4	15 + 42		X		X
	8.7	15 + 39	X		X	
	9.5	14 + 38		X		X
	9.6	14 + 40		X		X
	9.9	14 + 42		X		X
	10.2	10 + 41		X		X
	10.6	14 + 41	X		X	
	10.7	15 + 38	X		X	
	10.9	14 + 39		X	X	
	11.7	14 + 42	X		X	
	12.6	15 + 39		X	X	
	13.1	14 + 42	X		X	
	13.2	15 + 40		X	X	
	16.8	14 + 42		X		X
	17.7	14 + 42		X		X
	19.4	14 + 39		X		X
	20.2	14 + 42		X		X
	22.5	15 + 39	X		X	
	23.5	14 + 39		X		X

Species	Standard Length cm	Gill raker count	Parasite present	Parasite absent	Gill damage present	Gill damage absent
Hyporohamphus ihi	11.3	8 + 20	X		X	
	12.0	9 + 20		X		X
	12.2	7 + 19		X		X
	12.3	9 + 20	X		X	
	13.0	9 + 19	X		X	
	13.3	6 + 19	X		X	
	14.4	8 + 20	X		X	
	14.4	8 + 20	X		X	
	14.9	8 + 20	X		X	
	15.9	7 + 20		X		X
	16.2	7 + 20	X		X	
	16.5	8 + 19	X		X	
	16.5	7 + 20	X		X	
	17.6	8 + 19	X		X	
	18.3	7 + 21	X		X	
	18.8	7 + 21	X		X	
	19.1	9 + 21		X		X
	21.5	9 + 19	X		X	

REFERENCES

BOWMAN, T. E.

1960 Description and notes on the biology of *Lironeca puhi* n.sp. (Isopoda : Cymothoidae), parasite of the Hawaiian moray eel, *Gymnothorax eurostus* (Abbott). *Crustaceana* 1: 84-91.

BOWMAN, T. E. and R. N. MARISCAL

1968 *Renocila heterozot a,* new cymothoid isopod, with notes on its host, the anemone fish, *Amphiprion akallopisos,* in the Seychelles. *Crustaceana* 14 (1) : 97-104.

BRIGGS, P. T.

1970 Records of ectoparasitic isopods from Great South Bay, New York. *New York Fish Game J.* 17 (1): 55-57.

COLLETTE, B. B.

1974 The garfishes (HEMIRAMPHIDAE) of Australia and New Zealand. *Rec. Aust. Mus* 29 (2): 11-105.

HALE, H. M.

1926 Review of Australian isopods of the cymothoid group. Part II. *Trans. R. Soc. S. Aust.* 50: 201-234.

HUBBS, C. L. and K. F. LAGLER

1947 Fishes of the Great Lakes region. *Bull. Cranbrook Inst. Sci.* 26: 1-186.

STEPHENSON, A. B.

1971 Reproduction, age and growth of the garfish *Reporhamphus ihi* (Phillipps). Unpublished M.Sc. thesis, Auckland University, 1-42.

STEPHENSON, A. B. and D. R. ROBERTSON

The New Zealand species of *Trachurus* (Pisces : Carangidae). *J. R. Soc. N.Z.* in press.

TURNER, W. R. and R. B. ROE

1967 Occurrence of the parasitic isopod *Olencira praegustator* in the yellowfin menhaden *Brevoortia smithi. Trans. Am. Fish Soc.* 96: 357-359.

INDEX TO VOLUME 13

Acteon variegatus 158

Adventive plants 95

Allium neapolitanum 98

Allium roseum bulbiferum 99

Aphanes microcarpa 97

Atys naucum 160

Balcis (Pictobalcis) articulata 143

Bangerter, E. B.

New and interesting records of adventive plants from the Auckland Institute and Museum Herbarium 2 95

Barbarea intermedia 95

Barbarea vulgaris 96

Bratcher, T. W. O. Cernohorsky and —

Notes on the taxonomy of Indo-Pacific Terebridae (Mollusca: Gastropoda), with description of a new species 131

Bulla vernicosa 159

Bursa bubo lissostoma 152

Bursa verrucosa 152

Calystegia silvatica 98

Capulus (Krebsia) liberatus 144

Cardamine flexuosa 96

Cardiapoda placenta 146

Casmaria ponderosa perryi 149

Cernohorsky, W. O.

The taxonomy of some Indo-Pacific Mollusca. Part 4. With descriptions of new taxa and remarks on *Nassarius coppingeri* (Smith) 111

Cernohorsky, W. O., and T. Bratcher

Notes on the taxonomy of Indo-Pacific Terebridae (Mollusca: Gastropoda), with description of a new species 131

Charonia lampas rubicunda 151

Charonia tritonis 151

Cheeseman 101

Chicoreus ramosus 153

Claraxis cf *illustris* 158

Codonophilus imbricatus 167

Conuber conica 146

Conus kermadecensis 157

Crassostrea gigas 162

Cronia (Ergalatax) contracta 123
Cronia ochrostoma 122
Davidson, Janet M.
Additional evidence from the excavations at Skipper's Ridge, (N40/7), Opito, Coromandel Peninsula 1
A Nukuoro fishing kit in the Pitt Rivers Museum, Oxford 9
Dolabrifera brazieri 160
Epitonium (Gyroscala) perplexum 158
Erosaria cernica tomlini 144
Escallonia montevidensis 97
Eudolium pyriforme 151
Eulima perspicua 143
Euphorbia stricta 96
Excavations 1, 29
Fasciolaria (Pleuroploca) filamentosa 156
Filipendula ulmaria 97
Fish
buccal parasites 167
gill damage 167
Fishing kit 9
Fox, Aileen
Pa and other sites in the Parua Bay District, Whangaroa, Northland 13
Fusinus genticus 156
Fusinus novaehollandiae 156
Gallium parisiense var. *trichocarpum* 98
Glaucus atlanticus 161
Gonocarpus trichostachyus 109
Goulding, Jeanne H.
Notes on the Cheeseman Herbarium Part 3. Exchange with Australian herbaria from before 1900 to 1923 101
Haloragacae 109
Hastula matheroniana 139
Hinea brasiliana 142
Hipponix cf *foliaceus* 143
Hydatina albocincta 159
Hydatina physis 159
Hyporohamphus ihi 167
Indo-Pacific Mollusca 111
Indo-Pacific Terebridae 131

Irona melanosticta 167
Isopoda 167
Lapeirousia laxa 99
Latiaxis lischkeanus 154
Latiaxis wormaldi 154
Latirus gibbulus 156
Leahy, Anne
Whakamoenga Cave, Taupo, N94/7. A report on the ecology, economy and stratigraphy 29
Limaria orientalis 163
Limulatys reliquus 160
Liniaxis sertata 155
Lopha cristagalli 162
Lophiotoma abbreviata 157
Lychnis flos-cuculi 96
Lyncina vitellus 144
Malea pomum 150
Mentha X *citrata* 98
Mitra hilli 111
Mollusca 111, 131, 141
Moore, P. R.
The Tahanga Basalt: an important stone resource in North Island prehistory 77
Morula (Neothais) chaldea 154
Murex (Ocenebra) infans 116
Muricopsis noduliferus 119
Muricopsis orri 116
Myochama tasmanica 164
Nassarius coppingeri 128
Nassarius (Alectrion) glans particeps 155
Nassarius (Alectrion) spiratus 155
Natica (Notocochlis) migratoria 146
National Museum of New South Wales 104
National Museum of Victoria 103
Nembrotha kubaryana 161
Nembrotha morosa 161
Nukuoro 9
Obsidian 87

Orchard, A. E.
Rediscovery of *Gonocarpus trichostachyus* (Haloragaceae) 109
Pa sites 13
Panicum dichotomiflorum 99
Parua Bay 13
Pedicularia pacifica 145
Philine angasi 159
Phos (Strongylocera) textilis 126
Polinices (Mammilla) mammatus 147
Polinices (Mammilla) melanostomoides 147
Polinices (Mammilla) simiae 147
Polinices (Polinices) tawhitirahia 147
Polygonum arenastrum 96
Poromya laevis 164
Powell, A. W. B.
On the considerable influx of warm water molluscs that have invaded northern New Zealand waters within recent years 141
Pteria levitata 162
Queensland Herbarium 101
Radiocarbon dating 46, 87
Rapana venosa 153
Raphanus maritimus 96
Ratifusus adjunctus 155
Recluzia rollandiana 158
Roya kermadecensis 142
Semicassis bisulcata sophia 148
Septifer bilocularis 161
Sison amomum 98
Skipper's Ridge 1
Spinidrupa euracantha 121
Spinosipella ericia 164
Stephenson, A. B.
Gill damage in fish produced by buccal parasites 167
Stomatia phymotis 142
Tahanga basalt 77
Tellina (Arcopaginula) inflata 163
Terebra amanda 131
Terebra circumcincta 157

Terebra funiculata 133
Terebra parkinsoni 137
Terebra punctatostriata 134
Terebra quoygaimardi 135
Terebra undulata 137
Theora (Endopleura) lubrica 163
Tonna cumingii 149
Tonna dolium 149
Tonna luteostoma 149
Tonna melanostoma 150
Tonna olearium 150
Tonna perdix 150
Trachurus declivis 167
Trachurus novaezelandiae 167
Trophon (Emozamia) licinus 153
Tulbaghia violacea 99
Turritriton labiosus 152
Umbraculum sinicum 160
Vexillum (Pusia) rubrum 114
Vexillum (Pusia) salisburyi 114
Vicia disperma 97
Volva (Phenacovolva) longirostrata 145
Western Australia 109
Whakamoenga Cave 29
Xenophalium royanum 148
Xenophalium thomsoni 148

RECORDS AND BULLETIN OF THE AUCKLAND INSTITUTE AND MUSEUM

Instructions for Authors

The *Records* and *Bulletins* contain the results of original research dealing with material in the collections of the Museum, and research carried out by members of the Museum staff in their particular subjects. The fields covered include taxonomic and general botany and zoology, palaeontology, geology and anthropology (archaeology and ethnography).

Before completion of a manuscript, authors should refer to papers on a similar subject in the most recently published volume for detail of format required. Any doubts should be referred to the Editor. Standard rules for scientific papers and taxonomy apply; an acceptable guide for style is the New Zealand Government Printing Office Style Book (1971 edition).

Manuscripts should be typed, double-spaced on one side of white foolscap, International A4, or quarto sheets, with a 2.5 cm (or 1 inch) margin on *both* sides of page. Two copies of text are required, second copies of figures are preferred but not demanded. Manuscripts should not be in booklet form, but supplied with figures, figure captions, tables with captions above, all separate, with only an indication of position required in the text.

Abstracts are required except for brief papers with adequate title.

Figures (particularly groups of figures) and tables should be composed to page proportions, with due regard to saving space, and must be supplied ready for reduction (where necessary) to the printed page size or less (allowing for captions — above tables, below figures), preferably upright on page but sideways on page accepted (where necessary). Figures for fold-outs will only be allowed in special circumstances. Individual figures (whether grouped or not) should be numbered consecutively in arabic numerals (*not* 1a, b, c, etc) regardless of whether they are photographs or line drawings. Figures and tables *must* be referred to in the text and should be numbered in order of reference where possible.

All measurements must be given in metric (SI) units; equivalents in other units may be given in parenthesis.

Entries listed under "References" *must* be referred to in the text; this may not be necessary for a "Bibliography" or "Selected Bibliography" provided such listing is explained in the text. Book titles need not be abbreviated but names of journals should be abbreviated to known standards (as in "The world list of scientific periodicals" 4th edition, or as in the journal itself, or by a combination of recognised abbreviations), but need not be over-abbreviated. Names of countries may be abbreviated but those of cities or provinces are preferred not abbreviated. English book titles should be in lower case except for the first letter of names, but names of journals should have all major words beginning with a capital letter. Those of foreign languages should have capital letter usage of the language concerned.

Authors are responsible for the accuracy of their data, references and quotations, for their conclusions and remarks, and also for corrections to proofs. Authors (whether single or joint) will receive 50 free reprints.

Papers may be offered to the Editor at any time but those received for the Records after 31 March of any year may not be considered for publication that year. All papers will be submitted to the Editorial Committee and may be submitted to a referee.

UNITY PRESS LTD